

# Glossary

**Absolute sound intensity (I)**, the energy carried by the waves per second through an area of one square metre, as opposed to a relative decibel rating (dB).

**Absorbed dose**, radiation that deposits one joule of energy per kilogram of tissue. It has the units of one gray (Gy).

**Acceleration**, the rate at which the velocity changes with time.

**Accuracy**, a measure of how close a measurement is to an accepted value. The terms absolute error and relative error are used.

**Active device**, any semiconductor component that can change the form of electrical signals it receives — such as diodes, transistors and integrated circuits.

**Activity**, the number of radioactive disintegrations per second within a radionuclide.

**Alternating current (AC)**, an electric current that reverses direction of flow of charge during its cycles.

**Ammeter**, an instrument for measuring electric current.

**Amplitude**, the maximum displacement of an oscillating system from equilibrium.

**Analog**, an electrical signal whose magnitude is continuously variable.

**Angle of incidence**, the angle between the incident ray and the normal to the surface.

**Angle of refraction**, the angle between the refracted ray and the normal to the interface.

**Angular velocity**, the velocity of an object travelling in a circle and expressed in degrees (or radians) per unit of time.

**Antinodes**, result from the intersection of two crests or two troughs producing super crests and troughs.

**Archimedes' principle**, when an object is wholly or partially immersed in a fluid, the upthrust on the object is equal to the weight of the fluid displaced.

**Astigmatism**, occurs if a person sees objects or parts of an object blurred in a particular direction while other parts are in focus.

**Atomic mass**, the number of protons and neutrons in the nucleus of an atom. Sometimes called mass number.

**Atomic number**, the number of protons in the atomic nucleus of an atom.

**Avogadro's number ( $N_A$ )**, the number of particles in a mole of a substance and is equal to  $6.02 \times 10^{23}$  particles.

**Barometer**, an instrument used to measure atmospheric pressure often by use of a mercury column or an evacuated metal box (Bourdon gauge).

**Beats**, periodic variations in loudness heard when sound waves of slightly different frequencies occur together. The constructive and destructive interference of these sound waves causes a sound that represents the difference in frequency.

**Biasing**, the process of providing the correct DC operating voltages for semiconductor devices such as diodes and transistors.

**Binding energy**, the energy converted from mass when a nucleus is formed from its constituent nuclear particles, all initially in their free state.

**Black hole**, describes a region of space that contains matter so dense that even light cannot escape its gravitational force.

**Bosons**, the fundamental gauge particles of the Standard Model together with hadrons and leptons. The gauge bosons carry the fundamental forces of nature such as the electromagnetic photon and the gravitational graviton.

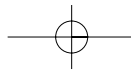
**Boyle's law**, states that for a fixed mass of gas at constant temperature the volume of the gas varies inversely with the pressure.

**Capacitor**, component used to store electric charge in circuits. Types include electrolytic, plastic film and ceramic.

**Cathode ray oscilloscope (CRO)**, instrument used to display rapidly varying voltage wave shapes in electronic circuit testing.

**Central maximum**, the antinodal line through the centre of an interference pattern. All points on this line are equidistant from the two sources.

**Centre of curvature**, of a mirror is the centre of the sphere that the mirror forms a part of.



**Centre of mass**, the point at which the whole mass of an object is considered to be concentrated for the purpose of applying the laws of motion.

**Centripetal force**, the force directed inward that keeps any object moving in a curve.

**Chain reaction**, one in which the products of the reaction initiate further reactions. These can be controlled chain reactions such as in nuclear fusion reactors or uncontrolled chain reactions as in the nuclear bomb.

**Charles' law**, states that for a confined gas where the pressure remains constant, the volume of the gas is directly proportional to its Kelvin temperature.

**Circuit**, a closed pathway for the flow of electric current containing a source of EMF, conductors and load devices.

**Coefficient of friction**, the frictional force divided by the normal contact force for a given surface type.

**Coefficient of linear expansion ( $\alpha$ )**, of a solid is the change in length of a one metre length of a solid due to a temperature change of one degree Celsius.

**Coefficient of volume expansion ( $\beta$ )**, of a liquid is the change in volume per cubic metre of a liquid due to a temperature change of one degree Celsius.

**Coherent**, another term for waves that are in phase or sources producing wave crests at the same time.

**Compressional wave**, or longitudinal wave, occurs when the particles of the medium vibrate in the same direction as the direction of propagation of the wave.

**Computed tomography (CT)**, a modern medical imaging process producing X-ray slices of the body by rotating an X-ray scanner about the body. Often called a CAT scan.

**Conduction**, the process where heat energy is transferred through a medium by the vibrating particles of the medium, but without the particles moving with the heat energy transfer.

**Conductor**, a substance that passes the flow of electric current, as opposed to an insulator.

**Control rod**, a substance, such as cadmium, used to absorb neutrons within a nuclear reactor.

**Convection**, the process where heat energy is transferred through a medium by the particles of the materials, which actually move with the heat flow.

**Coolant**, a liquid that circulates through the reactor core to remove excess heat energy and stop it from overheating. Water and heavy water (deuterium oxide  $D_2O$ ) are often used.

**Coulomb's law**, states that the magnitude and direction of the electrostatic force between two charges depends directly on the sign and magnitude of the charges and inversely on the square of the distance between them.

**Critical angle**, the angle of incidence that produces total internal reflection within an optical system.

**Critical mass**, the minimum mass required to sustain a chain reaction.

**Decay series**, a series of radioactive decays; for example,  $^{238}U$  decays by a series of alpha and beta decays to  $^{206}Pb$ .

**Diffraction**, the bending of waves as they pass through a slit or around the edges of objects.

**Digital**, an electrical signal whose magnitude exists in discrete steps from zero to some fixed value.

**Diode**, a semiconductor PN junction component used to control the direction of flow of DC current.

**Dioptre**, a lens maker's unit that defines the optical power of a lens. It is equivalent to the reciprocal of the focal length (in metres).

**Direct current (DC)**, an electric current that has one direction of flow of charge continuously.

**Dispersion**, the separation of white light into its component wavelengths or colours.

**Displacement**, the change in position of an object in a given direction.

**Doping**, the process of adding chemical impurities to semiconductor crystalline materials to increase conductivity.

**Dose equivalent**, to quantify the potential of radiation to damage and ultimately kill cells, physicists use the sievert (Sv) unit. For example, for X-rays,  $\gamma$ -rays and  $\beta$ -particles  $1 \text{ Gy} = 1 \text{ Sv}$ .

**Effective dose**, the dose that is obtained by summing the equivalent doses in all tissues and organs of the body weighted by their sensitivity to radiation.

**Efficiency**, a measure of the useful energy output compared with the energy input.

**Elastic collision**, one in which kinetic energy is conserved.

**Elastic potential energy**, the energy stored in a spring or other elastic body by virtue of its distortion, or change in shape.

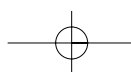
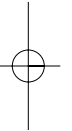
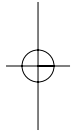
**Electric current**, a flow of electric charge defined as conventional current (positive charge flow) and electron flow (negative charge flow).

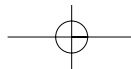
**Electric field**, a zone of influence where a force acts on any electric charge brought into it. Represented with electric field lines.

**Electric potential difference**, the work done per unit charge as the charge is moved between two points in an electric field. Measured in volts.

**Electrical resistance**, the opposition to the flow of electric current in any conductor. The larger the resistance (ohm), the smaller the current flow for a given voltage.

**Electromagnetic induction**, the process of inducing an EMF in a conductor by a changing magnetic flux.





**Electromagnetic relay**, a switching device using a small current through a solenoid to control a much larger current via an electromagnetic field.

**Electromagnetic waves**, those that require no medium for transmission and travel at the speed of light in a vacuum. Include long wavelength radio waves through to short wavelength gamma rays, called the electromagnetic spectrum.

**Electromotive force (EMF)**, the energy per unit charge supplied by a source of electric current.

**Electroscope**, one of the earliest instruments used to detect electrical charge or ionising radiation. An electroscope contains two thin pivoted metal foils inside a protective container.

**Energy level diagram**, shows the discrete energy level series that characterises the allowed electron energies in a particular atom's excited states.

**Enrichment**, the process of concentrating nuclear fuel to about 5% of the U-235 isotope so as to have a self-sustaining chain reaction.

**Entropy**, a measure of the orderliness of the particles of a system.

**Error**, discrepancy between an instrumental measurement of a quantity and its actual value. The causes of error may be random or systematic.

**Escape velocity**, the velocity needed to escape a planet's gravitational pull. For Earth it is  $11.2 \text{ km s}^{-1}$ .

**Extrapolation**, a graphical method that involves extending a line past the first or last data points.

**Ferromagnetic**, the class of material that is strongly attracted by magnets, as opposed to diamagnetic and paramagnetic materials.

**Flat plate collectors**, used in a common method of collecting energy from the sun in order to produce hot water. Utilises flat blackened absorbing surfaces.

**Fluid**, a substance that can flow, such as liquids, gases and plasma.

**Fluorescence**, the emission of light during the absorption of radiation from other sources.

**Fraunhofer lines**, dark absorption lines in the solar spectrum caused by atoms present in the low pressure solar atmosphere.

**Frequency**, the number of oscillations of a wave source per second, measured in hertz (Hz).

**Friction**, a force that resists motion between two surfaces in contact. May be either dynamic or static.

**Fundamental frequency**, the lowest natural frequency produced by an object or musical instrument.

**Galvanometer**, an instrument used to measure the magnitude and direction of electric currents.

**Gauge pressure**, the difference between atmospheric pressure and the pressure in a connected vessel.

**Gravitational mass**, a measure of the pull of gravity on an object. A spring balance is often used to measure gravitational mass.

**Gravitational potential energy**, the stored energy of an object by virtue of its position above a reference surface.

**Hadrons**, those nuclear constituents of matter influenced by the strong nuclear force. They include baryons and mesons. The proton and the neutron are the most well known examples.

**Half-life**, the time taken for half the radioactive atoms in a sample to decay.

**Heat**, term used to describe the internal energy transferred throughout the heating process.

**Hooke's law**, states that the displacement of a spring is proportional to the force applied.

**Hydrostatics**, the science of fluids at rest, as opposed to hydrodynamics.

**Independent variable**, the one in which a change is made to determine the effect on the dependent variable.

**Inductor**, an electronic component used to store energy in a magnetic field. Types include solenoids, relay coils and choke coils.

**Inertial mass**, a measure of resistance to motion. If a known force is applied to different objects, then the resultant acceleration is related directly to mass.

**Inertial reference frame**, one in which Newton's first law of inertia is valid. Rotating or otherwise accelerating frames of reference are non-inertial frames.

**Instantaneous speed**, the speed as measured over a very small period of time.

**Integrated circuit**, an active miniaturised circuit component that contains complex internal circuits fabricated from a body of semiconductor material. Types include linear and digital.

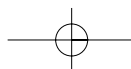
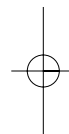
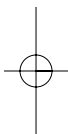
**Interference**, occurs with multiple wave sources when crests and troughs interact to either reinforce or cause cancellation at a point.

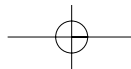
**Internal energy**, energy associated with the random vibrations or motions of electrons, atoms and molecules within an object; for example, chemical, heat and electrical energy.

**Interpolation**, determining the value of a measurement in between two or more other measurements. The usual method is by using a graph.

**Ionising radiation**, radiation that causes an atom to absorb so much energy that an electron completely escapes from the atom and a positive ion is produced.

**Isotopes**, nuclei with the same number of protons in their nuclei and the same chemical symbol, yet differing in the number of neutrons in their nuclei. Their atomic numbers will be identical but their atomic masses will be different.





**Kinetic energy**, energy possessed by virtue of the motion of an object.

**Kirchhoff's laws**, the circuit laws relating to current and voltage within electrical networks. The current junction law states that the sum of all currents entering any circuit junction is equal to the sum of all currents leaving that junction point. The voltage loop law states that the algebraic sum of all voltage changes encountered in any complete closed circuit loop is equal to zero.

**Law of conservation of energy**, energy is not lost, it just gets transferred from one place to another.

**Law of conservation of momentum**, in a closed system, the change in momentum is zero.

**Leptons**, those subatomic particles influenced by the weak interaction force, with the most common examples being electrons and neutrinos.

**Light-year (ly)**, the distance travelled by light in one year. Numerically it is equal to  $9.5 \times 10^{15}$  m.

**Logic circuits**, a basic class of digital electronic circuits or ICs that act as switches, latches, counters and timers.

**Luminescence**, the property of emitting light, such as from paint containing radioactive radium in the pigment.

**Magnetic flux density**, the total number of magnetic field lines or flux passing per unit area in a magnetic field. Measured in teslas (T).

**Magnetic resonance imaging (MRI)**, a diagnostic medical imaging technique using the magnetic properties of the hydrogen atoms present in the various body tissues.

**Manometer**, instrument for measuring liquid and gas pressures of moderate range in the laboratory. A U-tube manometer is partially filled with a liquid such as mercury or water.

**Mass**, a characteristic of a body's resistance to motion. Also called inertia.

**Mass defect**, the mass that has been converted to binding energy, that is, energy that binds the nuclear particles together.

**Mass spectrometer**, an instrument used to separate gaseous ions or isotopes in a magnetic field according to their mass differences.

**Matter waves**, the wavelike behaviour of matter as exhibited by subatomic particles. Originally suggested by Louis de Broglie.

**Mechanical waves**, waves that require an elastic medium for the transfer of energy.

**Microscopy**, the technique of using optical or electron waves to view very small objects. Primary types are the light microscope, SEM, TEM and STM.

**Moderator**, a substance that slows neutrons around the reactor core. Examples are carbon (graphite), water, heavy water ( $D_2O$ ), or liquid sodium.

**Momentum**, a vector quantity, being the product of a scalar (mass) and a vector (velocity).

**Monochromatic light**, light consisting of only one wavelength. Light may also be polychromatic.

**Motor principle**, a conductor carrying an electric current has a force exerted upon it if it is placed within a magnetic field. Basis of electric motors, where the force is actually a torque produced on a rotor assembly.

**Mutual induction**, the induction of an AC EMF in one solenoid by the varying magnetic field of a closely positioned second solenoid.

**Node**, is created by the interacting of a trough of one wave and a crest of another, producing a point of zero displacement.

**Normal reaction force**, the force pushing on an object normal (perpendicular) to the surface.

**Nuclear fission**, the division of a nucleus into roughly two equal parts, at the same time emitting one, two or three neutrons.

**Nuclear fusion**, the formation of a single nucleus of higher mass by the combination of lighter nuclei. The reaction may also produce high energy, neutrons, protons, etc. In the sun four hydrogen nuclei are fused into a single helium nucleus in a three step process called the proton-proton cycle.

**Nuclide**, used to describe a particular atomic species, for example C-12.

**Ohm's law**, states that the current flowing through a conductor is directly proportional to the potential difference applied across the ends of the conductor, provided that temperature and other physical factors are kept constant.

**Operational amplifier**, a linear IC representing a very high gain voltage amplifier designed to amplify signals over a wide frequency range. An example is the 741 Op Amp.

**Overtones**, integer multiples of the fundamental vibration frequency. Also called harmonics, they play a large part in musical instrument sound quality.

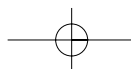
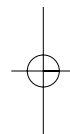
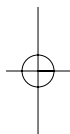
**Parallel connection**, circuit connections that allow multiple circuit paths that branch and join, with a common voltage drop across each component.

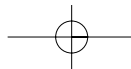
**Pascal's principle**, pressure applied at any point to a fluid in a closed vessel is transmitted equally to every other point in the fluid.

**Periodic motion**, one in which the object travels over the same path in a repetitive manner; for example, a pendulum, with a given period measured in seconds.

**Photoelectric effect**, the process whereby electrons are emitted by a metal when illuminated by light of sufficiently high photon energy.

**Photovoltaic cells**, semiconductor materials that provide direct conversion of the Sun's radiation into electrical energy. Most common are the various types of silicon solar cells.





**Polariser**, a device that allows only one component of the electromagnetic field to pass through. Crossed polarisers will not allow any energy through.

**Potentiometer**, a variable resistor, usually containing three connection points, that is used as a voltage divider.

**Power**, a measure of the rate of energy output. It has the units joules per second or watts.

**Presbyopia**, the inability to focus on distant or close objects — a mixture of hypermetropia (long-sightedness) and myopia (short-sightedness).

**Pressure**, the force per unit area acting on a surface, measured in  $\text{N m}^{-2}$  or pascals (Pa).

**Proper time**, time of an event as measured by observers for which the event occurs at one place. Contrast this with dilated time ( $t$ ) or relativistic time. Dilated time is longer than proper time.

**Quantum mechanics**, the mathematical model including wave equations, electron positional probability and the uncertainty principle, that is the basis of the modern description of the atom.

**Quarks**, the fundamental building blocks of hadron particles held together with gauge boson force particles called gluons. The Standard Model allows for eight gluons and six quarks.

**Radiation**, energy travelling through space. It can be transmitted in the form of waves, or as energetic particles.

**Radioactive decay**, the break-up of nuclei by either natural or artificially induced means.

**Range**, the horizontal displacement of a projectile moving in a gravity field.

**Rare earth magnets**, those modern materials made from rare earth element alloys that are very strongly ferromagnetic; for example, neodymium iron boride.

**Reactance**, the AC equivalent of resistance, a property that is dependent on circuit frequency. Types include both capacitive and inductive.

**Rectification**, a process using semiconductor diodes to convert AC voltages to DC voltages.

**Refracting telescope**, consists of two convex lenses. The objective lens has a long focal length and the eyepiece lens has a short focal length. These lenses are set up so their focal points coincide.

**Refraction**, the bending of waves at the boundary or interface, as they go from one medium to another.

**Regular or specular reflection**, occurs when parallel rays incident on a surface are reflected parallel. Reflection may also be diffuse.

**Resonance**, occurs when a body vibrates at its natural frequency, or a circuit oscillates at one particular frequency.

**Rest length**, the distance as measured by an observer at rest to the measuring instrument.

**Reverberation time**, the time it takes for the sound intensity to fall to one millionth of its original intensity, that is, to fall by 60 dB.

**RMS**, the root mean square method of measuring AC voltage magnitudes, which represents the equivalent DC rating in terms of resistance energy dissipation.

**Rotational inertia**, is different from mass because for a rotating object not all the mass is travelling at the same speed — the outside goes faster than the inside. How the mass is distributed in that object will determine how difficult it is to start or stop the object rotating.

**Scalar quantities**, those that do not include a direction; for example, mass.

**Schwarzschild radius**, the minimum distance from which it is still just possible to escape from a black hole. The boundary is called the event horizon.

**Scientific notation**, a shorthand means of expressing numbers and is often called exponential notation; for example,  $3.5 \times 10^{20}$ . Order of magnitude is the nearest power of ten.

**Scintigraphy**, the process of using gamma radiation to form images of body organs and tissues following injection of a suitable radiopharmaceutical compound. The process uses a gamma camera.

**Scintillation**, impacts of charged subatomic particles on a fluorescent screen or within a crystal in which flashes of light occur.

**Semiconductor**, crystalline material made from doped silicon in either P-type or N-type modes. These materials show a decrease in resistance as temperature rises.

**Series connection**, circuit connections that allow only single path current flow with the same current through each component.

**Significant figures**, those integers of a measurement known with certainty plus the next integer.

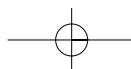
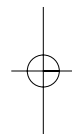
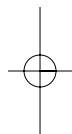
**Simple harmonic motion**, periodic motion in which the displacement is proportional to the force but in the opposite direction.

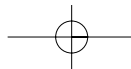
**Solar design**, the principles of dwelling construction that increase the use of solar energy efficient design. Include both passive and active design elements.

**Sound**, a form of energy produced by the vibrations of objects and carried by longitudinal mechanical waves. Characteristics include pitch, quality, timbre and frequency range.

**Special relativity**, the laws of physics have the same form in all inertial reference frames, and that light propagates through empty space with a definite speed ( $c$ ) independent of the speed of the source or observer.

**Specific gravity (SG)**, defined as the ratio of the mass of an object in air compared with the mass of an equal volume of water. Also called relative density.





**Specific heat capacity ( $c$ )**, defined as the amount of energy required to raise the temperature of one kilogram of a substance by one degree Celsius or by one kelvin.

**Specific latent heat of fusion**, the amount of energy required to melt one kilogram of a substance at its melting point.

**Specific latent heat of vapourisation**, the amount of energy to change one kilogram of a substance from a liquid to a gas, at its boiling point.

**Spherical aberration**, the inability of a convex lens or a concave mirror to focus light to a precise point.

**Split-ring commutator**, a special contact assembly on a rotating coil shaft that allows the direction of current to be reversed every half-cycle in a motor or a generator.

**Square wave clock**, a digital IC producing a square wave voltage signal output used in precision timing processes.

**Standard Model**, summarises the known constituents of matter as well as the interactions between them. Consists of two parts called the electroweak theory and quantum chromodynamics.

**Stroboscope**, an instrument, which in its most common form consists of a xenon flash tube similar to that found in a camera flash. It can be made to flash at variable rates from about one hertz to many kilohertz.

**Strong force**, that which binds adjacent nucleons together. It is a very short-ranged force, which decreases rapidly as nuclear separation increases.

**Superposition**, the process of creating a resulting waveform by adding the displacements, from the equilibrium positions of two interacting waves.

**Temperature**, of an object is a measure of the average kinetic energy of its particles.

**Terminal velocity**, when the speed of an object falling through a fluid becomes constant.

**Thermal conductivity ( $k$ )**, of any material is a measure of the rate of flow of heat through one square metre of a one metre thick layer of the material which has a temperature difference of one kelvin between each side.

**Thermal energy**, the sum of the kinetic and potential energies of all the particles of a substance.

**Thermal neutrons**, or slow neutrons, as distinct from high energy neutrons, which have to be slowed down by a moderator if they are to initiate any further nuclear reactions.

**Time constant**, the feature of any RC circuit that determines the time for the voltage across the capacitor to reach 63% of its final value. Also occurs in LC circuits.

**Time dilation**, the slowing down of time because of the effects of gravity or of high speed motion. 'Moving clocks are measured to run slowly.'

**Total internal reflection**, occurs when light travelling from a more optically dense to a less optically dense medium is reflected from the interface rather than transmitted.

**Transformer**, an electrical device using mutual induction between a primary and a secondary coil to achieve AC voltage level changes.

**Transistor**, an active three terminal semiconductor device used to switch and/or amplify electrical signals.

**Transverse waves**, waves where each point of the wave vibrates perpendicularly to the direction the wave is travelling.

**Ultrasonography**, process of using ultrasonic sound waves to probe the bodies of patients in medicine or properties of materials in engineering and physics.

**Ultraviolet radiation**, electromagnetic energy whose wavelengths stretch from 400 nm down to 1.0 nm. Classified into 3 bands, UV-A, -B, -C. The cause of serious sunburn or skin cancer.

**Uncertainty**, a measure of how confidently a measurement or result can be stated. It is a direct result of the limitations of an instrument.

**Uncertainty principle**, Heisenberg's quantum mechanical principle, which states the impossibility of very accurately measuring both the position and the momentum of a fundamental particle at the same time.

**Unified atomic mass unit ( $u$ )**, one twelfth the mass of an atom of the carbon isotope of atomic mass 12.0000 (that is,  $^{12}\text{C}$ ). The unified mass unit includes the masses of the six electrons of the carbon atom:  $1 u = 1.6606 \times 10^{-27} \text{ kg}$ .

**Vector quantity**, one that requires both magnitude and direction for its specification.

**Velocity**, the rate of change of displacement with time.

**Voltage divider**, a circuit type using a potentiometer or various discrete resistors to divide a source of voltage into smaller values.

**Voltage regulator**, a circuit that achieves very high stability of a DC output voltage. Often uses a three terminal linear IC.

**Voltmeter**, an instrument for measuring potential difference or voltage.

**Wavelength ( $\lambda$ )**, the minimum distance between two points on the wave that are in phase.

**Wave particle duality**, the fact that electromagnetic radiation can be simultaneously considered as either a wave or as a particle stream.

**Weight**, a measure of the force of gravity acting on a mass, which will vary depending on what gravitational forces it is being subjected to.

**Work**, defined as the product of the force and the distance moved in the direction of the applied force. It is measured in joules.

