

# Glossary

**absolute scale of temperature** *see* thermodynamic scale

**absolute zero** The temperature at which a system has minimum internal energy; equivalent to  $-273.15^{\circ}\text{C}$ .

**absorption line spectrum** A dark line of a unique wavelength seen in a continuous spectrum.

**acceleration** The rate of change of an object's velocity:

$$a = \frac{\Delta v}{\Delta t}$$

Unit:  $\text{m s}^{-2}$ .

**accuracy** An accurate value of a measured quantity is one which is close to the true value of the quantity.

**acoustic impedance** Acoustic impedance  $Z$  is the product of the density  $\rho$  of a substance and the speed  $c$  of sound in that substance ( $Z = \rho c$ ).

Unit:  $\text{kg m}^{-2} \text{s}^{-1}$ .

**activity** The rate of decay or disintegration of nuclei in a radioactive sample.

**amorphous** Describes a material whose particles are arranged in a disordered way.

**ampere** The SI unit of electric current.

**amplitude modulation** A form of modulation where the signal causes variations in the amplitude of a carrier wave.

**amplitude** The maximum displacement of a particle from its equilibrium position.

**analogue signal** A signal that is continuously variable, having a continuum of possible values.

**analogue-to-digital conversion (ADC)** Conversion of a continuous analogue signal to discrete digital numbers.

**angular displacement** The angle through which an object moves in a circle.

**angular frequency** The rate of change of angle expressed in radian per second:

$$\text{angular frequency } \omega = \frac{2\pi}{T}$$

**angular velocity** The rate of change of the angular position of an object as it moves along a curved path.

**antinode** A point on a stationary wave with maximum amplitude.

**antiphase** Describes two waves or oscillations that are  $180^{\circ}$  out of phase.

**astronomical unit** The average distance of the Earth from the Sun.

**attenuation** The gradual loss in strength or intensity of a signal.

**average speed** The total distance travelled by an object divided by the total time taken.

**Avogadro constant** The number of particles in one mole

of any substance ( $6.02 \times 10^{23} \text{ mol}^{-1}$ ), denoted  $N_A$ .

**bandwidth (communications)** A measure of the width of a range of frequencies being transmitted.

**base station** A receiver and transmitter used to maintain contact with a number of mobile phones (cell phones) in a local area.

**best fit line** A line drawn through the points plotted on a graph so that it passes through as many points as possible, taking into consideration a balance between the number of points above and below the line.

**binding energy** The minimum external energy required to separate all the neutrons and protons of a nucleus.

**bit** A basic unit of information storage. The amount of information stored by a device that exists in only two distinct states, usually given as the binary digits 0 and 1.

**Boyle's law** The pressure exerted by a fixed mass of gas is inversely proportional to its volume, provided the temperature of the gas remains constant.

**braking radiation** X-rays produced when electrons are decelerated (also called Bremsstrahlung radiation).

**brittle** Describes a material that shows no plastic deformation and breaks just beyond its elastic limit.

**Brownian motion** The random movement of small particles caused by bombardment of invisible molecules.

**capacitance** The ratio of charge stored by a capacitor to the potential difference across it.

**carbon-dating** A technique used to date relics using the carbon-14 isotope.

**carrier wave** a waveform (usually sinusoidal) that is modulated with an input signal to carry information.

**cellular exchange** A switching centre connecting all the base stations in an area.

**centre of gravity** The point where the entire weight of an object appears to act.

**centripetal force** The net force acting on an object moving in a circle; it is always directed towards the centre of the circle.

**chain reaction** An exponential growth of a fission reaction caused by the increasing flux of neutrons causing fission.

**characteristic radiation** Very intense X-rays produced in an X-ray tube having specific wavelengths that depend on the target metal.

**charge carrier** Any charged particles, such as electrons, responsible for a current.

**Charles's law** The volume occupied by a gas at constant pressure is directly proportional to its thermodynamic (absolute) temperature.

**closed system** A system of interacting objects where there are no external forces.

**coaxial cable** An electrical cable with an inner conductor surrounded by a tubular insulating layer and an outside conducting layer.

**coherent** Two sources are coherent when they emit waves with a constant phase difference.

**collimated beam** A parallel-sided beam of radiation.

**collimator** A device for producing a parallel beam of radiation.

**components (of a vector)** The magnitudes of a vector quantity in two perpendicular directions.

**compression** A region in a sound wave where the air pressure is greater than its mean value.

**compressive** Describes a force that squeezes an object.

**computerised axial tomography** A technique where X-rays are used to image slices of the body in order to produce a computerised 3-D image.

**conservation of momentum** In a closed system, when bodies interact, the total momentum in any specified direction remains constant.

**constructive interference** When two waves reinforce to give increased amplitude.

**contact force** The force an object exerts on another with which it is in contact.

**contrast media** Materials such as barium that easily absorb X-rays. A contrast medium is used to reveal the outlines or edges of soft tissues in an X-ray image.

**contrast** In a high-contrast image, there is a big difference in brightness between bright and dark areas.

**control rods** Rods of a neutron-absorbing material used to reduce the rate of a nuclear chain reaction.

**coolant** A substance used to transfer thermal energy from the core of a nuclear reactor.

**coulomb** The SI unit of electrical charge. A charge of 1 C passes a point when a current of 1 A flows for 1 s.  $1 \text{ C} = 1 \text{ A s}$

**Coulomb's law** Any two point charges exert an electrical force on each other that is proportional to the product of their charges and inversely proportional to the square of the distance between them.

**count rate** The number of particles (beta or alpha) or gamma-ray photons detected per unit time by a Geiger-Müller tube. Count rate is always a fraction of the activity of a sample.

**cross-linking (cross-talk)** A signal transmitted in one circuit or channel picked up, undesirably, in another circuit or channel.

**crystalline** Describes a material whose particles are arranged in an ordered way.

**damped** Describes an oscillatory motion where the amplitude decreases with time due to energy losses.

**de Broglie wavelength** The wavelength associated with a moving electron given by the equation:

$$\lambda = \frac{h}{mv}$$

**decay constant** The constant  $\lambda$  for an isotope that appears in the equation  $A = \lambda N$ . It is equal to the probability of an isotope decaying per unit time interval.

**decibel** A logarithmic unit of measurement that expresses the relative sizes of two powers using the formula  $10 \lg \left( \frac{P_1}{P_2} \right)$ .

**density** The mass per unit volume of a material:

$$\rho = \frac{m}{V}$$

Unit:  $\text{kg m}^{-3}$ .

**dependent variable** The variable in an experiment which is controlled by the experimenter.

**destructive interference** When two waves cancel to give reduced amplitude.

**diffraction** The spreading of a wave when it passes through a gap or past the edge of an object.

**digital signal** A signal that has only a few possible values, often only two.

**digital-to-analogue conversion (DAC)** Conversion of a series of digital numbers into a continuous analogue signal.

**dispersion** The splitting of light into its different wavelengths.

**displacement** The distance moved by an object in a particular direction (measured from a fixed starting point).

**drag** A force that resists movement of a body through a fluid.

**ductile** Describes a material that can easily be drawn into wires (e.g. copper).

**dynamics** A study of motion involving force and mass.

**e.m.f.** The total work done when unit charge moves round a complete circuit. Unit:  $\text{J C}^{-1}$  or volt (V).

**efficiency** The ratio of useful output energy to the total input energy for a device, expressed as a percentage:

$$\text{efficiency} = \frac{\text{useful output energy}}{\text{total input energy}} \times 100\%$$

**Einstein relation** This refers to the equation for the energy of a photon – that is:

$$E = hf \quad \text{or} \quad E = \frac{hc}{\lambda}$$

**elastic** Describes a material which will return to its original shape when the forces acting on it are removed.

**elastic hysteresis** This occurs when the extension of an elastic material is different in loading and unloading.

**elastic limit** The value of stress beyond which an object will not return to its original dimensions.

**elastic potential energy** Energy stored in an extended or compressed material.

**electric charge** A property of many particles which gives rise to a force between them.

**electric field** A region in which a charged body experiences a force.

**electric field strength** The force per unit positive charge at a point. Unit:  $\text{V m}^{-1}$  or  $\text{N C}^{-1}$ .

**electric potential** The energy per unit charge due to a charged body's position in an electric field.

**electrical resistance** The ratio of potential difference to current. Unit: ohm ( $\Omega$ ).

**electrolyte** An electrically conducting solution. The conduction is due to positive and negative ions in the solution.

**electromagnetic spectrum** A family of waves that travel through a vacuum at a speed of  $3.0 \times 10^8 \text{ m s}^{-1}$ .

**electronvolt** The energy gained by an electron travelling through a p.d. of 1 volt.  $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ .

**elementary charge** The smallest unit of charge that a particle or an object can have. It has a magnitude of  $1.6 \times 10^{-19} \text{ C}$ .

**emission line spectrum** A sharp and bright line of a unique wavelength seen in a spectrum.

**energy level** The quantised energy states of an electron in an atom.

**equation of state** Equation for an ideal gas:

$$pV = nRT \quad \text{or} \quad pV = NkT$$

(Also known as the ideal gas equation.)

**equations of motion** Four equations that can be used to determine quantities such as displacement, initial velocity, final velocity and acceleration.

**equilibrium** An object in equilibrium is either at rest or travelling with a constant velocity because the net force on it is zero.

**errors** Inaccuracies when taking measurements.

**evaporation** The process by which a liquid becomes a gas at a temperature below its boiling point.

**exponential decay graph** A decaying graph that has a constant-ratio property for a given interval of time.

**exponential decay** A quantity that has a 'constant-ratio property' with respect to time.

**extension** The change in the length of a material from its original length.

**farad** The unit of capacitance.  $1 \text{ F} = 1 \text{ C V}^{-1}$ .

**Faraday's law of electromagnetic induction** The induced e.m.f. is proportional to the rate of change of magnetic flux linkage.

**field lines** Lines drawn to represent the strength and direction of a field of force.

**field of force** A region of space where an object feels a force; the force may be gravitational, electric, magnetic, etc.

**First law of thermodynamics** The increase in internal energy of a body is equal to the thermal energy transferred to it by heating plus the mechanical work done on it.

**Fleming's left-hand (motor) rule** This rule is used to predict the force experienced by a current-carrying conductor placed in an external magnetic field: thumb  $\rightarrow$  motion, first finger  $\rightarrow$  magnetic field and second finger  $\rightarrow$  conventional current.

**Fleming's right-hand (generator) rule** This rule is used to predict the direction of the induced current or e.m.f. in a conductor moved at right angles to a magnetic field: thumb  $\rightarrow$  motion, first finger  $\rightarrow$  magnetic field and second finger  $\rightarrow$  induced conventional current.

**force constant** The ratio of force to extension for a spring or a wire. Unit:  $\text{N m}^{-1}$ .

**forced oscillation** An oscillation caused by an external driving force whose frequency is equal to that of the driving force.

**free oscillation** An oscillation whose frequency is the natural frequency of the oscillator.

**frequency** The number of oscillations of a particle per unit time. Unit: hertz (Hz).

**frequency modulation** A form of modulation where the signal causes variations in the frequency of a carrier wave.

**fundamental frequency** The lowest-frequency stationary wave for a particular system.

**gain** The voltage gain of an amplifier is the ratio of the output voltage to the input voltage.

**geostationary orbit** The orbit of an artificial satellite which has a period equal to one day so that the satellite remains above the same point on the Earth's equator. From Earth the satellite appears to be stationary.

**gravitational field** A region where any object with mass experiences a force.

**gravitational field strength** The gravitational force experienced by an object per unit mass:

$$g = \frac{F}{m}$$

**gravitational potential** The gravitational potential energy per unit mass at a point in a gravitational field.

**gravitational potential energy** The energy a body has due to its position in a gravitational field.

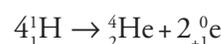
**ground state** The lowest energy state that can be occupied by an electron in an atom.

**half-life** The mean time taken for half the number of active nuclei in a radioactive sample to decay.

**harmonic** A wave of frequency  $n$  times the fundamental frequency, where  $n$  is an integer.

**Hooke's law** The extension produced in an object is proportional to the force producing it, provided the elastic limit is not exceeded.

**hydrogen burning** A sequence of nuclear reactions in which four protons fuse together to produce a helium nucleus:



**ideal gas equation** Equation for an ideal gas:

$$pV = nRT \quad \text{or} \quad pV = NkT$$

(Also known as the equation of state.)

**ideal gas** A gas that behaves according to the equations  $pV = nRT$  and  $pV = NkT$ .

**image intensifier** A device used to change a low-intensity X-ray image into a bright visual image.

**impedance matching** The reduction in intensity of reflected ultrasound at the boundary between two substances, achieved when the two substances have similar acoustic impedances.

**impulse** The product of the force  $F$  and the time  $\Delta t$  for which it acts:

$$\text{impulse} = F\Delta t$$

**independent variable** The variable which changes when the dependent variable changes.

**induced nuclear fission** A fission reaction started when a neutron is absorbed by a nucleus.

**inelastic** A collision is inelastic when the kinetic energy is not conserved; some is transferred to other forms such as heat. Momentum and total energy are always conserved.

**inertia** A measure of the mass of an object. A massive object has a large inertia.

**instantaneous speed** The speed of an object measured over a very short period of time.

**intensity** The power transmitted normally through a surface per unit area:

$$\text{intensity} = \frac{\text{power}}{\text{cross-sectional area}}$$

Unit:  $\text{W m}^{-2}$ .

**interference** The formation of points of cancellation and reinforcement where two coherent waves pass through each other.

**internal energy** The sum of the random distribution of kinetic and potential energies of the atoms or molecules in a system.

**internal resistance** The resistance of an e.m.f. source. The internal resistance of a battery is due to its chemicals.

**inverting amplifier** A circuit, involving the use of an amplifier, where the output is  $180^\circ$  out of phase with the input.

**ion** An atom with a net positive or negative charge.

**isotopes** Nuclei of the same element with a different number of neutrons but the same number of protons.

**I–V characteristic** A graph of current against voltage for a particular component. You can identify a component from its  $I$ – $V$  graph.

**kilowatt-hour** The energy transferred by a 1 kW device in a time of 1 hour.  $1 \text{ kW h} = 3.6 \text{ MJ}$ .

**kinematics** A study of motion using quantities such as time, distance, displacement, speed, velocity and acceleration.

**kinetic energy** Energy of an object due to its motion.

**kinetic theory of gases** A model based on the microscopic motion of atoms or molecules of a gas.

**Kirchhoff's first law** The sum of the currents entering any point (or junction) in a circuit is equal to the sum of the currents leaving that same point. This law conveys the conservation of charge.

**Kirchhoff's second law** The sum of the e.m.f.s round a closed loop in a circuit is equal to the sum of p.d.s in that same loop.

**Larmor frequency** The frequency of precession of nuclei in an external magnetic field.

**Lenz's law** The induced current or e.m.f. is in a direction so as to produce effects which oppose the change producing it.

**light-dependent resistor (LDR)** A resistor whose resistance decreases as the intensity of light falling on it increases.

**light-emitting diode (LED)** A semiconductor component that emits light when it conducts.

**linear momentum** The product of an object's mass and its velocity,  $p = mv$ . Momentum is a vector quantity.

**longitudinal wave** A wave in which particles oscillate along the direction in which the wave travels.

**lost volts** The difference between the e.m.f. and the terminal p.d. It is also equal to the voltage across the internal resistance.

**macroscopic** Visible to the naked eye.

**magnetic field** A force field in which a magnet, a wire carrying a current, or a moving charge experiences a force.

**magnetic flux density** The strength of a magnetic field. Magnetic flux density  $B$  is defined as:

$$B = \frac{F}{Il}$$

where  $F$  is the force experienced by a conductor in the magnetic field,  $I$  is the current in the conductor and  $l$  is the length of the conductor in the magnetic field. (The conductor is at right angles to the field.)

**magnetic flux linkage** The product of magnetic flux and the number of turns. Unit: weber (Wb).

**magnetic flux** The product of magnetic flux density normal to a circuit and the cross-sectional area of the circuit. Unit: weber (Wb).

**magnetic resonance imaging (MRI)** a medical imaging technique which uses nuclear magnetic resonance.

**mass** A measure of the amount of matter within an object. Unit: kilogram (kg).

**mass defect** The difference between the total mass of the individual, separate nucleons and the mass of the nucleus.

**mean drift velocity** The average speed of charged particles along the length of a conductor.

**microscopic** Too small to be viewed with the naked eye.

**microwave link** A communications system that uses a beam of radio waves in the microwave frequency range to transmit audio, data or video information.

**mobile phone (cell phone)** An electronic device used for mobile communication by connecting to a cellular network of base stations.

**moderator** A material used in a nuclear reactor to slow down fast-moving neutrons so that they have a greater chance of interacting with the fissile nuclei.

**modulation** The process of using one waveform to alter the frequency, amplitude or phase of another waveform.

**mole** The amount of matter which contains  $6.02 \times 10^{23}$  particles.

**moment** The moment of a force about a point is the magnitude of the force, multiplied by the perpendicular distance of the point from the line of the force. Unit: N m.

**natural frequency** The unforced frequency of oscillation of a freely oscillating object.

**negative feedback** The output of a system acts to oppose changes to the input of the system, with the result that the changes are reduced.

**neutron number** The number of neutrons in the nucleus of an atom.

**newton** The force that will give a 1 kg mass an acceleration of  $1 \text{ m s}^{-2}$  in the direction of the force.  $1 \text{ N} = 1 \text{ kg m s}^{-2}$ .

**Newton's first law of motion** An object will remain at rest or keep travelling at constant velocity unless it is acted on by an external force.

**Newton's law of gravitation** Any two point masses attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of their separation.

**Newton's second law of motion** The net force acting on an object is equal to the rate of change of its momentum. The net force and the change in momentum are in the same direction.

**Newton's third law of motion** When two bodies interact, the forces they exert on each other are equal and opposite.

**node** A point on a stationary wave with zero amplitude.

**noise** An unwanted random addition to a transmitted signal.

**non-inverting amplifier** A circuit, involving the use of an amplifier, where the output is in phase with the input.

**nuclear fission** The splitting of a nucleus (e.g.  $^{235}_{92}\text{U}$ ) into two large fragments and a small number of neutrons.

**nuclear fusion** A nuclear reaction where two light nuclei (e.g.  $^2_1\text{H}$ ) join together to form a heavier but more stable nucleus.

**nuclear magnetic resonance** A process in which radio waves are absorbed or emitted by nuclei spinning in a magnetic field.

**nuclear model of the atom** A model of the atom in which negative charges (electrons) are distributed outside a tiny nucleus of positive charge.

**nucleon number** The number of neutrons and protons in the nucleus of an atom (also called mass number).

**nucleon** A particle found in an atomic nucleus, i.e. a neutron or a proton.

**nucleus** The tiny central region of the atom that contains most of the mass of the atom and all of its positive charge.

**nuclide** A specific combination of protons and neutrons in a nucleus.

**Ohm's law** The current in a metallic conductor is directly proportional to the potential difference across its ends, provided its temperature remains constant.

**operational amplifier (op-amp)** A high-gain electronic d.c. voltage amplifier with differential inputs and, usually, a single output.

**optic fibre** A glass or plastic fibre that carries light along its length.

**oscillates** Another term for 'vibrates'.

**oscillation** A repetitive back-and-forth or up-and-down motion.

**parallel** A term used when components are connected across each other in a circuit.

**path difference** The difference in the distances travelled by two waves from coherent sources at a particular point.

**perfectly elastic** A collision is perfectly elastic when kinetic energy is conserved. Momentum and total energy are always conserved.

**period** The time taken by an object (e.g. a planet) to complete one orbit. The period is also the time taken for one complete oscillation of a vibrating object. Unit: second (s).

**phase difference** The fraction of an oscillation between the vibrations of two oscillating particles, expressed in degrees or radians.

**phase** Describes the point that an oscillating mass has reached in a complete cycle.

**photoelectric effect** An interaction between a photon and an electron in which the electron is removed from the atom.

**photomultiplier tubes** Devices used in a gamma camera to change the energy of an incident  $\gamma$ -ray photon into an electrical pulse.

**photon** A quantum of electromagnetic energy.

**piezo-electric crystal** A material that produces an e.m.f. when it is compressed. Also, when a voltage is applied across it in one direction, it shrinks slightly.

**piezo-electric effect** The production of an e.m.f. across the faces of a crystal when the crystal is compressed.

**Planck constant** The constant which links the energy of a photon and its frequency, given by the equation:

$$E = hf$$

**plane polarised** Describes transverse waves that oscillate in only one plane.

**plastic deformation** The deformation of a material beyond the elastic limit.

**plum pudding model** A model of the atom in which negative charges are distributed throughout a sphere of positive charge.

**point mass** An object with mass that is represented as a point (dot) because its size is extremely small compared with the separation between objects.

**polymer** A material containing large molecules composed of repeating structural units.

**positron** A positively charged particle with mass equal to that of an electron.

**potential difference (p.d.)** The energy lost per unit charge by charges passing through a component. Unit:  $\text{J C}^{-1}$  or volt (V).

**potential divider** A circuit in which two or more components are connected in series to a supply. The output voltage from the circuit is taken across one of the components.

**potentiometer** A circuit which allows the measurement of an e.m.f. by comparison with a known e.m.f.

**power** The rate at which energy is transferred or the rate at which work is done. Unit: watt (W).

**precession** The movement of the axis of a spinning object (proton) around another axis.

**precision** The smallest change in value that can be measured by an instrument or an operator. A precise measurement is one obtained several times and achieving the same, or very similar, values.

**pressure** The force acting normally per unit area of a surface:

$$p = \frac{F}{A}$$

Unit:  $\text{N m}^{-2}$  or Pa.

**principle of moments** The sum of clockwise moments about a point is equal to the sum of anticlockwise moments about the same point for a body in equilibrium.

**principle of superposition** When two or more waves meet at a point, the resultant displacement is the sum of the displacements of the individual waves.

**progressive wave** A wave that carries energy from one place to another.

**projectile** Any object thrown in the Earth's gravitational field.

**proton number** The number of protons in the nucleus of an atom (also called atomic number).

**public switched telephone network** The network which connects public telephones throughout the world.

**radian** An alternative unit for measuring angles.  $2\pi$  radians =  $360^\circ$  or  $\pi$  radians =  $180^\circ$ .

**range** The horizontal distance covered by an object.

**rarefaction** A region in a sound wave where the air pressure is less than its mean value.

**rectification** The process of converting alternating current (a.c.) into direct current (d.c.).

**reflection** The bouncing back of a wave from a surface.

**refraction** The change in direction of a wave as it crosses an interface between two materials where its speed changes.

**regeneration** Restoring a signal to its original form, usually removing or reducing noise and increasing signal strength.

**relative speed** The magnitude of the difference in velocities between two objects.

**relaxation time** The time taken for the nuclei to fall back to their lower energy state.

**relay** An electrically operated switch, caused to open and close by current in a coil.

**repeater** An electronic device that receives a signal and retransmits it.

**resistivity** The property of a material defined by:

$$\text{resistivity} = \frac{\text{resistance} \times \text{cross-sectional area}}{\text{length}}$$

$$\rho = \frac{RA}{L}$$

Unit:  $\Omega \text{ m}$ .

**resistor** An electrical component whose resistance in a circuit remains constant. Its resistance is independent of current or potential difference.

**resonance** The forced motion of an oscillator characterised by maximum amplitude when the forcing frequency matches the oscillator's natural frequency. A system absorbs maximum energy from a source when the source frequency is equal to the natural frequency of the system.

**rest mass** The mass of an isolated stationary particle.

**resultant force** The net force acting on an object.

**resultant** Total or net.

**right-hand grip rule** A rule for finding the direction of the magnetic field inside a solenoid. If the right hand grips the solenoid with the fingers following the direction of the current around the solenoid, then the thumb points in the direction of the magnetic field.

**sampling** Taking the value of a continuous signal at regular intervals.

**scalar quantity** A scalar quantity has magnitude but no direction.

**semiconductor diode** An electrical component made from a semiconductor material (e.g. silicon) that only conducts in one direction. A diode in 'reverse bias' has an infinite resistance.

**sensor** A device that produces an output (usually a voltage) in response to an input.

**series** A term used when components are connected end-to-end in a circuit.

**sharpness** The degree of resolution in an image, which determines the smallest item that can be identified.

**sidebands** A band of frequencies above or below the carrier frequency produced as a result of modulation.

**simple harmonic motion** Motion of an oscillator where its acceleration is directly proportional to its displacement from its equilibrium position and is directed towards that position.

**solenoid** A long current-carrying coil used to generate a uniform magnetic field within its core.

**specific heat capacity** The energy required per unit mass of a substance to raise its temperature by 1 K (or 1°C). Unit:  $\text{J kg}^{-1} \text{K}^{-1}$ .

**specific latent heat of fusion** The energy required per kilogram of a substance to change it from

solid to liquid without a change in temperature.

Unit:  $\text{J kg}^{-1}$ .

**specific latent heat of vaporisation** The energy required per kilogram of a substance to change it from liquid to gas without a change in temperature.

Unit:  $\text{J kg}^{-1}$ .

**speed** The rate of change of the distance moved by an object:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Unit:  $\text{ms}^{-1}$ .

**speed** The rate of change of the distance moved by an object:

**spin** A fundamental property of subatomic particles which is conserved during atomic and nuclear reactions.

**stationary wave** A wave pattern produced when two progressive waves of the same frequency travelling in opposite directions combine. It is characterised by nodes and antinodes. Also known as a standing wave.

**strain energy** The potential energy stored in an object when it is deformed elastically.

**strain gauge** A device that contains a fine wire sealed in plastic. Its electrical resistance changes when the object to which it is attached changes shape.

**strain** The extension per unit length produced by tensile or compressive forces:

$$\text{strain} = \frac{\text{extension}}{\text{original length}}$$

**stress** The force acting per unit cross-sectional area:

$$\text{stress} = \frac{\text{force}}{\text{cross-sectional area}}$$

**systematic error** An error in readings which is repeated through out an experiment, either producing a constant absolute error or a constant percentage error.

**tensile** A term used to denote tension or pull.

**terminal p.d.** The potential difference across the external resistor connected to an e.m.f. source.

**terminal velocity** The constant velocity of an object travelling through a fluid. The net force on the object is zero.

**tesla** The SI unit for magnetic flux density. Unit: tesla (T).  $1\text{ T} = 1\text{ N A}^{-1}\text{ m}^{-1}$ .

**thermal energy** Energy transferred from one object to another because of a temperature difference; another term for heat energy.

**thermal equilibrium** A condition when two or more objects in contact have the same temperature so that there is no net flow of energy between them.

**thermistor** A device whose electrical resistance changes when its temperature changes.

**thermocouple** A device consisting of wires of two different metals across which an e.m.f. is produced when the two junctions of the wires are at different temperatures

**thermodynamic scale** A temperature scale where temperature is measured in kelvin (K).

**threshold frequency** The minimum frequency of the electromagnetic radiation that will eject electrons from the surface of a metal.

**threshold voltage** The minimum forward bias voltage across a light-emitting diode (LED) when it starts to conduct and emit light.

**time constant** The time taken for the current, charge stored or p.d. to fall to  $1/e$  (about 37%) when a capacitor discharges through a resistor. It is also equal to the product of capacitance and resistance.

**torque** The product of one of the forces of a couple and the perpendicular distance between them.  
Unit: N m.

**tracers** Radioactive substances used to investigate the function of organs of the body.

**transducer** A general term used for any device that changes one form of energy into another.

**transition** When an electron makes a 'jump' between two energy levels.

**transverse wave** A wave in which the oscillation is at right angles to the direction in which the wave travels.

**triangle of forces** A closed triangle drawn for an object in equilibrium. The sides of the triangle represent the forces in both magnitude and direction.

**turns-ratio equation** An equation relating the ratio of voltages to the ratio of numbers of turns on the two coils of a transformer:

$$\frac{V_s}{V_p} = \frac{n_s}{n_p}$$

**ultimate tensile stress (UTS)** The maximum stress that a material can withstand.

$$\text{UTS} = \frac{\text{maximum force}}{\text{cross-sectional area}}$$

**unified atomic mass unit** A convenient unit used for the mass of atomic and nuclear particles (1 u is equal to  $\frac{1}{12}$  the mass of a  $^{12}\text{C}$  carbon atom).

$$1\text{ u} = 1.66 \times 10^{-27}\text{ kg}$$

**uniform acceleration** Acceleration that remains constant.

**uniform motion** Motion of an object travelling with a constant acceleration.

**upthrust** The upward force that a liquid exerts on a body floating or immersed in a liquid.

**vector addition** Using a drawing, often to scale, to find the resultant vector.

**vector quantity** A vector quantity has both magnitude and direction.

**vector triangle** A triangle drawn to determine the resultant of two vectors.

**velocity** The rate of change of the displacement of an object:

$$\text{velocity} = \frac{\text{change in displacement}}{\text{time}}$$

Unit:  $\text{m s}^{-1}$ . (You can think of velocity as 'speed in a certain direction'.)

**virtual earth approximation** An approximation where the two inputs of an op-amp are taken to be at the same potential.

**viscous forces** Forces that act on a body moving through a fluid that are caused by the resistance of the fluid.

**voxel** A small cube in a three dimensional picture, the equivalent of a pixel in a two-dimensional picture.

**wave** A periodic disturbance travelling through space, characterised by vibrating particles.

**wavelength** The distance between two adjacent peaks or troughs.

**weight** The force on an object caused by a gravitational field acting on its mass:

$$\text{weight} = \text{mass} \times \text{acceleration of free fall}$$

Unit: newton (N).

**wire-pair** A form of wiring in which the two conductors needed to carry a signal are placed close together.

**work done** The product of the force and the distance moved by the force in the direction of travel.

**work function** The minimum energy required by a single electron to escape the metal surface.

**X-ray tube** A device that produces X-rays when accelerated electrons hit a target metal.

**Young modulus** The ratio of stress to strain for a given material, resulting from tensile forces, provided Hooke's law is obeyed:

$$\text{Young modulus} = \frac{\text{stress}}{\text{strain}}$$

Unit: Pa (or MPa, GPa).

**zero error** A systematic error in an instrument that gives a non-zero reading when the true value of a quantity is zero.