A

a.f (audio frequency) amplifier
an amplifier that amplifies signals in the approximate range 10 Hz to 20 Hz

aberration
an image defect of which blurring and distortion are the most common image defects. Aberrations can occur with the use of both lenses and mirrors.

absolute magnitude (*M*)
the apparent magnitude of a star if it were at a distance of 10 pc from Earth.

absolute zero
the point where molecular motion becomes a minimum – the molecules have minimum kinetic energy but molecular motion does not cease.

absorbed dose (D)
the amount of energy *E* transferred to a particular unit mass *m*. The SI unit of absorbed dose is J kg^{-1} otherwise known as the Gray (Gy).

absorption spectrum
occurs when white light passes through a substance in the gaseous phase. Dark lines in the white light correspond to the wavelengths characteristic of the emission spectrum of the particular substance.

AC transformer
a device that can be used for increasing or decreasing ac voltages and currents.

acceleration
see average acceleration and instantaneous acceleration

accommodation
the ability of the eye to focus over this range is called accommodation and this is controlled by the ciliary muscles pulling or relaxing in order to change the focal length of the flexible eye lens. The eye has most accommodation for prolonged viewing when viewing at the far point.

accuracy
is an indication of how close a measurement is to the accepted value indicated by the relative or percentage error in the measurement. An accurate experiment has a low systematic error.

acoustic impedance
a measure of how easy it is to transmit sound through a aprticular medium. The unit of acoustic impedance is the rayl.

active solar heating
the use of solar collectors to convert solar energy into heat energy.

adiabatic
expansion or contraction is one in which no thermal energy *Q* is allowed to flow into or out of the system. For the entire adiabatic process, $Q = 0$.

aerial
a conductor designed to detect a transmitted EM signal

air resistance
a term that refers to the drag force exerted on object as they move through the atmosphere.

albedo (α)
at a surface, is the ratio between the incoming radiation and the amount reflected expressed as a coefficient or as a percentage. (Latin for white)

alpha-particle
a doubly ionised helium atom, that is a helium nucleus.

AM
see amplitude modulation

ammeter
an instrument used to measure the current flowing in an electric circuit and is always connected in series.

A-mode scan
measures the time lapsed between when the pulse is sent and the time the echo is received. The first echo is from the skin, the second and third pulses are from either side of the first organ, the fourth and fifth echo are from either side of the second organ. The pulse intensity decreases due to attenuation.

ampere
defined in terms of the force per unit length between parallel current-carrying conductors.

amplifier
any device that amplifies a signal

amplitude
the maximum displacement of a particle from its equilibrium position when executing SHM For wave motion it is the maximum displacement of the medium through which the wave travels.

amplitude modulation (AM)
the encoding of information on to a carrier wave by producing variations in the amplitude of the carrier wave.

angle of incidence
the angle between the direction of travel of the incident wave and the normal to the boundary

angle of refraction
the angle between the direction of travel of the refracted wave and the normal to the boundary

angular frequency (ω)
2π times the linear frequency.

angular magnification
the ratio θ/θ_0 is called the angular magnification M or magnifying power of the lens.

antineutrino
a particle with zero rest mass and zero charge that results from beta-minus decay and decay of a free neutron.

antinode
a point on a stationary wave where the displacement is zero.

antiparticles
all particles have antiparticles which are identical to the particle in mass and half-integral spin but are opposite in charge to their corresponding particle. Although antiparticles have the same mass as their particle pair, they have opposite charge, lepton number, baryon number and strangeness. Some electrically neutral bosons and mesons are their own antiparticle.

aperture
the length of the refracting surface on which the incident rays can be refracted.

apparent brightness
the apparent brightness of a star (b) is the energy received from the star per unit time per unit area of the Earth's surface.

apparent magnitude (m)
a measure of how bright a star appears. The scale is defined such that a difference in apparent magnitude of 5 corresponds to a factor of 100 in brightness. This means that 100 stars of magnitude 6 will produce as much power per unit area at the surface of the Earth as a single star of apparent magnitude 1. The higher the value of m the less bright is the star.

artificial transmutation
a process by which nuclei of an element can be induced to from nuclei of a different element often by the bombardment with neutrons.

APPCDC
Asia-Pacific Partnership for Clean Development and Climate, an organisation that proposed that, rather than imposing compulsory emission cuts, it would work in partnership to complement the Kyoto protocol. The six countries involved were Australia, China, India, Japan, South Korea and the USA.

astronomical unit (AU)
the average distance between Earth and the Sun. 1 AU = 1.50×10^{11} m.

atomic mass unit (u)
this is 1/12th of the mass of an atom of carbon-12.

attenuation
of an X-ray beam is the reduction in its intensity due to its passage through matter.

average acceleration
change in velocity over an interval of time divided by the time interval

average speed
change in distance over an interval of time divided by the time interval

average velocity
change in displacement over an interval of time divided by the time interval

Avogadro's number
one mole of a substance at 0°C and 101.3 kPa pressure (STP) contains 6.02×10^{23} particles.

B

bandwidth
the frequency range covered by the sideband frequencies

baryons
the 'heavyweights' amongst particles that make up matter, including the proton and the neutron. Other baryons include Lamda Λ0, Sigma Σ+, Σ0 and Σ-, Cascade Ξ0 and Ξ- and Omega Ω- particles to name but a few.

becquerel
this is 1 nuclear disintegration per second.

beta particle
a negative or a positive electron associated with radioactive decay.

Big Bang Theory
postulates that the Universe emerged from an enormously dense and hot state about 14 billion years ago. The size of the universe at its beginning was assumed to be extremely small with enormous temperature and pressure. It is assumed that a gigantic "explosion" occurred that created space, time and matter.

binary stars
two stars that orbit a common centre of gravity.

biological half-life (T_B)
of a material is the time taken for half the radioactive substance to be removed from the body by biological processes.

black hole
an object whose gravitational field strength at it surface is large enough to prevent light escaping from its surface/ an object whose escape velocity at its surface is equal to or greater than the free space speed of light.

black-body radiation
the radiation emitted by a 'perfect' emitter. The radiation is sometimes called 'temperature radiation' because the relative intensities of the emitted wavelengths are dependant only on the temperature of the black body.

breeder reactor
a nuclear fission reactor that creates or 'breeds' more fissionable material than consumed.

bremsstrahlung
when a fast-moving particle is rapidly decelerated or deflected by another target particle, it radiates most of its energy in the form of photons in what is known as bremsstrahlung or braking radiation in the X-ray region of the electromagnetic spectrum.

Brewster angle (ϕ)
the angle to the normal at which reflected light is completely plane polarized.

Brewster's law
the refractive index n of a substance is related to the Brewster angle *(ϕ) by $n = \tan\phi$.*

Brownian motion
the random, zig-zag motion observed when larger molecules or particles in motion collide with smaller molecules.

B-scan mode
(brightness-modulated scan), an array of transducers scan a slice in the body. Each echo is represented by a spot of a different shade of grey on an oscilloscope.

C

carrier wave
the name given to the wave that is altered by the superposition of the signal wave

cell phones
another name for mobile phones

centre of curvature C
the centre of the sphere of which the lens is made.

centripetal acceleration
the acceleration of a particle traveling in a circle.

centripetal force
the general name given to the force causing a particle to travel in a circle.

cepheid variables
stars whose luminosity varies with a regular frequency.

Chandrasekhar limit
the maximum mass of a star for it to become a white dwarf. ($1.4M_{sun}$)

change of state (of an ideal gas)
if some macroscopic property of the system has changed eg. phase, temperature, pressure, volume, mass, internal energy.

chemical energy
energy associated with chemical reactions.

chromatic aberration
produces coloured edges around an image. It can be minimised by using an achromatic doublet. It is made from converging crown glass lens and a diverging flint glass lens that are adhered together by canada balsam

coal
an organic material made up primarily of carbon, along with varying amounts of hydrogen, oxygen, nitrogen and sulfur. It is a sedimentary rock.

Coaxial cable
consists of a thin copper wire surrounded by an insulator which in turn is surrounded by a copper grid. This grid is also surrounded by an insulator.

cochlea
the most delicate organ in the hearing process and it contains many intricate structures that will not be fully investigated at this level. It consists of three chambers - two outer chambers, the scala vestibuli (top) and the scala typani (bottom), and an inner chamber called the scala media.

coefficient of volume (or cubical expansion) (β)
the fractional change in volume per degree change in temperature and is given by the relation:

coherent
when the filament of a light globe emits light, the atoms on the filament do not maintain a constant phase relationship because the filament atoms act independantly from each other.The light emitted is incoherent. However, in a laser, each photon of light is in phase with all the other photons. Laser light is coherent.

combined cycle gas turbines (CCGT)
a jet engine is used in place of the turbine to turn the generator. Natural gas is used to power the jet engine and the exhaust fumes from the jet engine are used to produce steam which turns the generator.

compression
digital data can be compressed enabling the same bandwidth to be used by several different broadcasting channels

computed tomography (CT) imaging
also called computed axial tomography (CAT) imaging, uses X-rays, scintillation detectors and computer technology to build up an axial scan of a section of an organ or part of the body with 256 grey shades.

conduction
the process by which a temperature difference causes the transfer of thermal energy from the hotter region of the body to the colder region by particle collision without there being any net movement of the substance itself.

conductor
have a low electrical resistance and are therefore able to carry an electric current withour much energy dissipation as heat.

cones
photoreceptors that have slow response rates, and are insensitive at low light levels but are sensitive to particular wavelengths of light, and give us our colour vision. There are around 6.5 million of them. It is thought that the cones can be divided into three colour groups - red cones (64%), green cones (32%), and blue cones (2%).

Conservation of energy
states that energy cannot be created or destroyed but only transformed into different forms. (See conservation of mass-energy and first law of thermodynamics)

Conservation of mass-energy
states that mass and energy are interchangeable and in any interaction mass-energy is conserved.

constellation
a collection of stars that form a recognisable group as viewed from Earth (e.g the Plough)

constructive interference
occurs when two or more waves overlap and their individual displacements add to give a displacement that is greater than any of the individual displacements.

control rods
the rate of nuclear fission in the reactor core can be controlled by inserting or removing the control rods. The control rods are constructed of materials that absorb neutrons.

convection
the process in which a temperature difference causes the mass movement of fluid particles from areas of high thermal energy to areas of low thermal energy (the colder region).

conventional current
flows from the positive to negative terminal.

coolant
a material that circulates through the reactor core and removes thermal energy transferring it to where it can do useful work by converting water into steam.

Coulomb's Law
the force F between two point charges q_1 and q_2 was directly proportional to the product of the two point charges and inversely proportional to the square of the distance between them r^2.

crest
the maximum displacement of a medium through which a wave travels.

critical angle
the angle, measured to the normal, at which a ray incident on a boundary between two media, will undergo total internal reflection in the more dense medium.

critical mass
the smallest possible amount of fissionable material that will sustain a chain reaction.

crude oil
a product of the decomposition of marine plants and animals that were rapidly buried in sedimentary basins where there was a lack of oxygen.

cyclotron
basically like a linac that has been wrapped into a tight spiral. it has the following important components.
dampingthe decrease with time of the amplitude of oscillations.

D

data transfer rate
the number of bits transmitted per second also called bit rate.

DC amplifier
another name for an operational amplifier

de Broglie hypothesis
Any particle with momentum can exhibit wave-like properties and its wavelength is given by the de Broglie formula .

degree of uncertainty
of a measurement is equal to half the limit of reading.

demodulator
removes the carrier wave leaving only the signal waves.

derived quantity
a quantity involving the measurement of two or more fundamental quantities.

destructive interference
occurs when two or more waves overlap and their individual displacements add to give a displacement that is less than any of the individual displacements.

differential amplifier
another term for an operational amplifier

diffraction
the bending and/or spreading of waves when they meet an obstruction or pass through an aperture.

diffusion
a property observed in solids, liquids and gases as something spreads out.

dioptre
the unit for the lens power is the dioptre D with the unit m^{-1}.

dispersion
when a narrow beam of white light undergoes refraction on entering a prism, the light spreads out into a spectrum of colours. The colours range from red at one side of the band, through orange, yellow, green, indigo, to violet at the other side of the band. The separation of the white light into its component colours is due to dispersion.

displacement
distance traveled in a specified direction

Doppler Effect
the phenomenon of the change in frequency that arises from the relative motion between a source and observer.

dosimetry
the study of radiation.

drag force
see air resistance

drift velocity
electrons entering at one end of the metal cause a similar number of electrons to be displaced from the other end, and the metal conducts. Even though they are accelerated along their path, it is estimated that the drift velocity is only a small fraction of a metre each second (about 10^{-4} m s^{-1}).

E

eccentricity
the earth's orbit around the Sun is not circular but rather elliptical and this will affect its orbit every 100 000 and 400 000 years which in turn leads to climate change.

eddy currents
any conductor that moves in a magnetic field has emf induced in it, and as such current, called eddy currents, will also be induced in the conductor. This current has a heating effect in the soft iron core of the transformer which causes a power loss termed an iron loss.

effective half-life (T_E) of the radioactive substance will be less than the physical half-life due to the biological half-life component.

efficiency
of an energy conversion process is the ratio of the useful energy output to the total energy input, usually expressed as a percentage.

Einstein photoelectric equation
relates the maximum kinetic energy of the emitted electrons, f is the frequency of the incident light, f_0 is the threshold frequency and h is the Planck constant

Einstein Principle of Equivalence
states that it is impossible to distinguish between gravitational and inertial effects.

elastic potential energy
the energy associated with a system subject to stress e.g. a stretched spring

electric current
the rate at which charge flows past a given cross-section.

electric field strength (electric field intensity)
at any point in space, E is equal to the force per unit charge exerted on a positive test charge, it is a vector quantity.

electric potential difference
between two points in a conductor is defined as the power dissipated per unit curretn in moving from one point to another.

electric potential energy
defined in terms of a point charge moving in an electric field as 'The electric potential at a point in an electric field is defined as being the work done per unit charge in bringing a small positive point charge from infinity to that point'.

electric potential energy
the energy associated with a particle due to its position in an electric field.

electrical energy
this is energy that is usually associated with an electric current and that is sometimes referred to incorrectly as electricity.

electrical resistance
the ratio of the potential difference across the material to the current that flows through it. The units of resistance are volts per ampere ($V\ A^{-1}$). However, a separate SI unit called the ohm Ω is defined as the resistance through which a current of 1 A flows when a potential difference of 1 V is applied.

electrical strain gauge
when a metal conducting wire is put under vertical strain, it will become longer and thinner and as a result its resistance will increase. An electrical strain gauge is a device that employs this principle.

electromagnetic waves
waves that consist of oscillating electric and magnetic fields. They are produced by the accelerated motion of electric charge.

electromotive force (emf)
the work per unit charge made available by an electrical source.

electron flow
flows from the negative to the positive terminal.

electron microscope
a microscope that utilizes the wave properties of electrons.

electron-volt (eV)
the energy acquired by an electron as a result of moving through a potential difference of one volt.

electrostatics
the study of stationary electric charges.

elementary particles
particles that have no internal structure, that is, they are not made out of any smaller constituents. The elementary particles are the leptons, quarks and exchange particles.

emission spectra
the spectra produced by excited gaseous atoms or molecules

emissivity
the ratio of the amount of energy radiated from a material at a certain temperature and the energy that would come from a blackbody at the same temperature and as such would be a number between 0 and 1.

energy
the capacity to do work

energy balance climate model
the word "balance" infers that the system is in equilibrium with no energy being accumulated in the earth's surface and atmosphere. This model attempts to account for the difference between the incoming radiation intensity and the outgoing radiation intensity, and the simplest energy balance model chooses temperature as the only variable to be considered.

energy degradation
when energy is transferred from one form to other forms, the energy before the transformation is equal to the energy after (Law of conservation of energy). However, some of the energy after the transformation may be in a less useful form, usually heat. We say that the energy has been degraded.

energy density
the amount of potential energy stored in a fuel per unit mass, or per unit volume depending on the fuel being discussed.

entropy
a thermodynamic function of the state of the system and can be interpreted as the amount of order or disorder of a system.

equipotential lines
lines that join points of equal potential in a gravitational or electric field.

equipotential surface
all points on an equipotential surface at the same potential.

equipotentials
regions in space where the electric potential of a charge distribution has a constant value.

ether
a substance that was thought to permeate the whole of space and that was at absolute rest.

evaporation
a change from the liquid state to the gaseous state that occurs at a temperature below the boiling point.

evaporative cooling
as a substance evaporates, it needs thermal energy input to replace its lost latent heat of vaporisation and this thermal energy can be obtained from the remaining liquid and its surroundings.

exchange particles
elementary particles that transmit the forces of nature.

exponential decay
when a quantity continuously halves in value in equal intervals of time, the quantity is said to decay exponentially.

exposure
is defined for X-radiation and γ-radiation as the total charge (Q) of ions of one sign (either electrons or positrons) produced in air when all the β-particles liberated by photons in a volume of air of mass m are completely stopped in air.

extrapolation
extending the line of best fit outside the plotted points of a graph.

F

far point
the position of the furthest object that can be brought into focus by the unaided eye. The far point of a normal eye is at infinity.

Faraday's Law
can be stated as 'the magnitude of the induced emf in a circuit is directly proportional to the rate of change of magneitc flux of flux linkage.

feedback resistance
the value of the resistance that feeds the output signal of a operational amplifier back to the input.

Feynman diagrams
so named for their inventor, the American physicist *Richard Feynman* (1918–1988). They were developed by Feynmann as a graphical tool to examine the conservation laws that govern particle interactions according to quantum electrodynamic theory.

film badge
a double emulsion photographic film that is placed inside a holder with an area of 3 cm by 5 cm that contains different thicknesses of plastic, an open window and 3 different metal plates. It is pinned to clothing and over a period of time the exposure to radiation results in a darkening of specific areas of the photographic film.

first harmonic (also fundamental)
the first possible mode of vibration of a stationary wave.

first law of thermodynamics
a statement of the Law of Conservation of Energy in which the equivalence of work and thermal energy transfer is taken into account. It can be stated as the heat added to a closed system equals the change in the internal energy of the system plus the work done by the system.

flux linkage (Φ)
If is the flux density through a cross-sectional area of a conductor with coils

focal length (f)
the distance between the principal focus and the centre of the refractingsurface.

forced oscillations
oscillations resulting from the application of an external, usually periodic force.

fossil fuels
naturally occurring fuels that have been formed from the remains of plants and animals over millions of years. The common fossil fuels are peat, coal, crude oil, oil shale, oil tar and natural gas.

fractional uncertainty
see relative uncertainty.

frame of reference
a set of coordinates used to define position

Fraunhofer diffraction
diffraction resulting from the source of light and the screen on which the diffraction pattern is produced being an infinite distance from the diffracting aperture.

frequency
linear frequency (f) is the number of complete oscillations a system makes in unit time.

frequency modulation (FM)
the encoding of information on to a carrier wave by producing variations in the frequency of the carrier wave.

Fresnel diffraction
diffraction resulting from either or both the source of light and the screen on which the diffraction pattern is produced being a finite distance from the diffracting aperture.

frictional force
the force that arises between two bodies in contact.

fundamental
(see first harmonic)

fundamental interactions/forces
all forces that appear in nature may be identified as one of four fundamental interactions, either the gravitational, weak, electromagnetic or strong interaction.

fundamental units
kilogram, metre, second, ampere, mole and Kelvin.

G

galaxies
A collection of stars held together by gravity.

gamma ray bursters
astronomical objects that emit intense bursts of gamma radiation thought to be due to the collapse of a rapidly rotating neutron star

gamma ray(s)
high frequency electromagnetic radiation, that is high energy photons.

generator
is essentially a device for producing electrical energy from mechanical energy.

geodesic
the shortest path followed by an object moving in space-time

geostationary satellite
a satellite that orbits Earth in a circular orbit above the equator and has an orbital period of one sidereal day

gluons
the exchange particle that is responsible the quark colour. Just as the positive and negative charges are associated with the electromagnetic force, a three colour charge are associated with quarks and gluons that bind the quarks together.

gravitational lensing
the bending of light by a gravitational field

gravitational mass
the mass that gives rise to the gravitational attraction between bodies as defined by Newton's law of gravity.

gravitational potential
the gravitational potential at a point in a gravitational field is defined as the work done per unit mass in moving a point mass from infinity to the point.

gravitational potential energy
the energy associated with a particle due to its position in a gravitational field.

gravitational red-shift
the observed frequency of light emitted from a source depends upon the position of the source in a gravitational field.

gravitational time dilation
the slowing of time due to a gravitational field

graviton
the exchange particle for the gravitational force. It is an inverse square force with an infinite range that affects all particles and acts on all mass/energy and it has a rest mass of zero.

H

hadrons
are not elementary particles because they are composed of quarks. Mesons consist of a quark and an antiquark. Baryons have three quarks. A proton has 2 up and 1 down quarks - uud, and the neutron has 2 down and I up quarks – ddu. Hadrons interact predominantly via the strong nuclear force, although they can also interact via the other forces.

half-life
see radioactive half-life

half-value thickness
is the thickness of a material that reduces the intensity of a monoenergetic X-ray beam to half its original value.

harmonic series
a series of musical notes arising from a particular fundamental frequency.

harmonics
the different possible modes of vibration of a stationary wave.

heat
the thermal energy that is absorbed, given up or transferred from one object to another.

heat capacity
see thermal capacity

heat engine
any device that converts thermal energy into work.

heat exchanger
a system basically acting as a heat engine driven by chemical reactions (the combustion of fossil fuels) or by nuclear reactions. The working fluid is water heated in a boiler that is converted to steam at high pressure.

heat pump
any device that can pump heat from a low-temperature reservoir to a high-temperature reservoir is called a heat pump.

heat
the non-mechanical transfer of energy between a system and its surroundings

Heisenberg Uncertainty Principle
The Uncertainty Principle was proposed by Werner Heisenberg in 1927 as explained in the text

Hertzsprung-Russell diagrams
a plot of the luminosity (or absolute magnitude) against temperature (or spectral class).

Hubble's law
The law states that the relative recession speed between galaxies is proportional to their separation.

I

ideal gas
a theoretical gas that obeys the equation of state of an ideal gas exactly.

ideal gases
obey the equation pV = nRT when there are no forces between molecules at all pressures, volumes and temperatures.

induced current
if the conductor is moved across the magnetic field, then a deflection occurs in the needle of the galvanometer in one direction. After a very short period of time, the needle returns to zero on the scale. The current produced is called an induced current.

inertia
a body's reluctance to change its state of motion.

inertial mass
the mass referred to in Newton's second law

inertial reference frame
a reference frame in which Newton's first law holds true

insolation
incoming solar radiation, it is mainly in the visible region of the electromagnetic spectrum (0.4 μm to 0.7 μm) and short-wave infra-red radiation.

instantaneous acceleration
the rate of change of velocity with time

instantaneous speed
the rate of change of distance with time

instantaneous velocity
the rate of change of displacement with time

insulator
the electrons are held tightly by the atomic nuclei and are not as free to move through a material. They can accumulate on the surface of the insulator but they are not conducting.

intensity
the energy that a wave transports per unit time across unit area of the medium through which it is travelling

interference pattern
the overall pattern produced by interfering waves

Intergovernmental Panel on Climate Change (IPCC)
in the 1980s, the United Nations Environment Programme in conjunction with the World Meteorological Organization set up a panel of government representatives and scientists to determine the factors that may contribute to climate change. The panel was known as the Intergovernmental Panel on Climate Change (IPCC).

internal energy
the sum total of the potential energy and the random kinetic energy of the molecules of the substance making up the system.

internal resistance
the resistance inside a source of electrical energy.

interpolation
drawing the line of best fit between the plotted points of a graph.

inverting amplifier
an operational amplifier in which the non-inverting input is connected to earth.

ionising radiation
when radiation causes ions to form it is called ionising radiation.

ionization current
the current in a gas that results from the ionization of the atoms or molecules of the gas.

ionization
the removal of an electron or electrons from an atom.

isobaric
a graph of pressure as a function of volume change when the pressure is kept constant. Such a process is said to be isobaric. Note that the work done by the gas is equal to the area under the curve.

isochoric
a graph of pressure as a function of volume change when the volume is kept constant. Such a process is said to be isochoric. When the volume is kept fixed, the curve of the transformation is said to be an isochore.

isolated system
a system where no energy of any kind enters or leaves the system.

isothermal process
a thermodynamic process in which the pressure and the volume are varied while the temperature is kept constant. In other words, when an ideal gas expands or is compressed at constant temperature, then the gas is said to undergo an isothermal expansion or compression.

isotopes
atoms of the same element with different numbers of neutrons in their nuclei.

K

Kelvin temperature
a fundamental quantity. It is the SI unit of thermodynamic temperature of the triple point of water. One degree Celsius is equal to 1 + 273 = 274 K.

Kepler's third law
this is the law of periods and states that that the average orbital radius R of a planet about the Sun is related to the period T of rotation of the plane by $R^3 = kT^2$ where k is a constant.

kilogram
the mass of a particular piece of platinum-iridium alloy that is kept in Sèvres, France.

kilowatt-hour (kW h)
the energy consumed when 1 kW of power is used for one hour.

kinetic energy
energy associated with motion

kinetic theory of a gas
when the moving particle theory is applied to gases it is generally called the kinetic theory of gases.

Kirchoff's current law – junction rule
the sum of the currents flowing into a point in a circuit equals the sum of the currents flowing out at that point.

Kirchoff's voltage law – loop rule
in a closed loop the sum of the emfs equals the sum of the potential drops.

Kyoto Protocol
this agreement required industrialized countries to reduce their emissions by 2012 to an average of 5 percent below 1990 levels. A system was developed to allow countries who had met this target to sell or trade their extra quota to countries having difficulty meeting their reduction deadlines.

L

laminations
to reduce the heating effect due to eddy currents, the soft-iron core is made of sheets of iron called laminations that are insulated from each other by an oxide layer on each lamination. This insulation prevents currents from moving from one lamination to the next.

laser
is actually an acronym 'light amplification by stimulated emission of radiation'. A laser is an instrument that has a power source and a light-amplifying substance. There are a variety of solid, liquid and gas lasers available on the market. The common laser used in the laboratory uses a helium- neon gas mixture as the light-amplifying substance.

latent heat of fusion
the quantiy of thermal energy required to change a substance from a solid at its melting point completely to a liquid at its melting point.

latent heat of vaporisation
the quantiy of thermal energy required to change a substance from a liquid at its boiling point completely to a gas at its boiling point.

Law of conservation of electric charge
in a closed system, the amount of charge is constant.

laws of reflection
the angle at which the waves are reflected from a barrier is equal to the angle at which they are incident on the barrier (the angles are measured to the normal to the barrier). All waves, including light, sound, water obey this rule. The normal and the rays associated with the incident and reflected rays all lie in the same plane.

lens
a transparent object with at least one curved surface but more commonly two curved faces. Most lenses are made of glass but perspex (lucite) and quartz lenses are common. They are used to correct defects of vision using spectacles and in optical instruments such as cameras, microscopes and refracting telescopes.

Lenz's Law
also known as the Second Law of Electromagnetic Induction and it can be stated as 'the direction of the induced emf is such that the current it causes to flow opposes the change producing it'.

leptons
particles that can travel on their own meaning that they are not trapped inside larger particles. Six distinct types called flavors have been identified along with their antiparticles.

light dependant resistor (LDR)
is a photo-condutive cell whose resistance changes with the intensity of the incident light.

light year
the distance that light travels in one year. 1 light year (ly) = 9.46×10^{15} m

limit of reading
of a measurement is equal to the smallest graduation of the scale of an instrument.

line spectrum
produced when the spectrum produced by excited gaseous atoms or molecules is passed through a slit and then through a dispersive medium such as a prism of diffraction grating and then brought to a focus on a screen.

linear accelerator (linac)
is a device that accelerates charged particles in a straight line inside a long evacuated tube.

linear attenuation coefficient
a beam of homogeneous, monoenergetic X-rays contains photons of only one energy and thus only one wavelength.

linear or lateral magnification m
(of a lens) is given by the ratio of the height of an image to the height of its object or the ratio of the image distance to the object distance. Linear magnification has no units.

longitudinal waves
in these types of wave, the source that produces the wave vibrates in the same direction as the direction of travel of the wave i.e. the direction in which the energy carried by the wave is propagated. The particles of the medium through which the wave travels vibrate in the same direction of travel of the wave (direction of energy propagation).

loudspeaker
a transducer that converts an amplified electrical signal into sound.

luminosity (L)
the total power radiated by a star.

M

Mach's Principle
states that inertial and gravitational mass are identical

macroscopic property
a property that can be observed. Physical properties such as melting point, boiling point, density, thermal conductivity, thermal expansion and electrical conductivity can be observed and measured.

magnetic flux (Φ)
through a small plane surface is the product of the flux density normal to the surface and the area of the surface. The unit of magnetic flux is the weber Wb.

magnetic force
a force experienced when a moving charge or a beam of moving charges is placed in a magnetic field.

magnifying power
see angular magnification.

main sequence stars
a grouping of stars on a Hertzsprung-Russell diagram that extends diagonally across the graph from high temperature, high luminosity to low temperature low luminosity. Stars on the main sequence derive the energy from hydrogen burning in the core of the star.

Malus' law
when light of intensity I_0 is incident on an analyzer whose transmission axis makes angle θ to the electric field vector, the intensity I of the transmitted light is given by $I = I_0 cos^2\theta$

mass
see gravitational mass and inertial mass

mass defect
The difference in mass between a nucleus and the sum of the mass of its constituent nucleons. The mass of a nucleus is always less than the sum of the mass of its constituent nucleons.

material dispersion
the spreading out of pulses as they travel along an optic fibre

matter waves
See de Broglie hypothesis

Maxwell's theory
states that electromagnetic radiation consists of oscillating electric and magnetic fields.

mesons
hadrons that can mediate the strong nuclear force. Like the first and second generation leptons, mesons only exist for a short time and they are thus very unstable.

metal structure
positive ions in a 'sea' of delocalised electrons.

method of mixtures
a common indirect method to determine the specific heat capacity of a solid and liquids is called the method of mixtures.

metre
the length of path traveled by light in a vacuum during a time interval of 1/299 792 453 second.

minimum angle of resolution
see Rayleigh criterion

mobile phone
a phone that is not connected by a landline to a telephone exchange

modal dispersion
a situation in which pulses associated with different waves in an optic fibre arrive at the detector at different times

moderator
a material that will slow down the fast neutrons to the speed of the slow thermal neutrons needed for a self-sustained reaction without absorbing the neutrons when they collide with the moderator material.

modes
the name given to the different paths followed by different waves in an optic fibre

modulation
the alteration of a wave form

mole
is the amount of substance that contains as many elementary particles as there are in 0.012 kg of carbon–12. The mole is a fundamental unit.

momentum
the product of mass and velocity

monochromatic
source of radiation is that has a extremely narrow band of frequencies or extremely small narrow wavelength band (or colour in the case of visible light). Most sources of light emit many different wavelengths. Laser light is monochromatic.

monomode fibres
a fibre in which there is only one transmission axis thereby eliminating modal dispersion

Morse code
an electronic communication system that used individual groups electrical pulses to represent letters and that were transmitted along wires

moving particle theory
the basic assumptions of this moving particle theory relevant to thermal energy are:

multiplexing
a means of increasing the bit rate by sending different sets of data apparently simultaneously.

N

natural frequency
the frequency of oscillation of a system that is not subjected to a periodic external force.

natural gas
a product of the decomposition of marine plants and animals that were rapidly buried in sedimentary basins where there was a lack of oxygen.

natural greenhouse effect
a phenomenon in which the natural greenhouse gases absorb the outgoing long wave radiation from the earth and re-radiate some of it back to the earth.

natural radioactivity
a property associated with certain naturally occurring elements in which they emit ionizing radiations.

near point
the position of the closest object that can be brought into focus by the unaided eye. The near point varies from person to person but it has been given an arbitrary value of 25 cm.

nebulae
a cloud of interstellar dust and gas.

nematic liquid crystal
a liquid crystal whose molecules are in the shape of a twisted helix.

neutron number
the number of neutrons in a nucleus

neutrons
an uncharged nucleon

nibble
a 4-bit binary word

node
a point on a stationary wave where the displacement is a maximum.

non-renewable source
one that is considered to be a temporary source that is depleted when it is used.

NTC thermistor
(negative temperature coefficient) the resistance decreases when the temperature rises and theytherefore pass more current.

nuclear binding energy
the energy required to separate the nucleus into it individual nucleons or the energy that would be released in assembling a nucleus from its individual nucleons.

nuclear energy
energy associated with nuclear reactions

nuclear fission
the splitting of a nucleus into two other nuclei.

nuclear fusion
the combining of two nuclei into a single nucleus

nuclear magnetic resonance
the basis of the diagnostic tool known as magnetic resonance imaging (MRI). It is a technique used for imaging blood flow and soft tissue in the body and is the preferred diagnostic imaging technique for studying the brain and the central nervous system. Rather than using X-rays as the source of radiation, it uses radiation in the radio region of the electromagnetic spectrum and magnetic energy to create cross-sectional slices of the body.

nucleon
a proton or a neutron.

nucleon number
the number of nucleons in a nucleus

nucleosynthesis
the different nuclear processes that take place in stars.

nuclide
the general term for a unique nucleus

numerical aperture
is related to the resolution of a lens, and the wavelength of the light (see text for formula)

Nyquist Theorem
states that the sampling signal must be equal to or greater than twice the signal frequency.

O

Ohm's Law
provided the physical conditions such as temperature are kept constant, the resistance is constant over a wide range of applied potential differences, and therefore the potential difference is directly proportional to the current flowing.

Olber's paradox
if Newton's model of a uniform, infinite Universe were correct, then the sky would always be bright. This paradox was first proposed by Henrich Olber in 1823.

operational amplifier
an amplifier with two inputs, very high input impedance and very high gain.

Oppenheimer–Volkoff limit
the maximum mass of a neutron star beyond which it will collapse to a black hole

optic fibres
a fibre in which the carrier wave is light.

optical microscope
a microscope using visible light and lenses to magnify small objects (usually used in biology and medicine)

order of magnitude
the power of ten closest to a number.

oscillating water column (OWC)
wave energy devices that convert wave energy to electrical energy. These can be moored to the ocean floor or built into cliffs or ocean retainer walls.

oscillations
another word for vibrations.

ossicles
a chain of three bones in the ear that transmit vibration form the ear drum to the cochlea. They are called the malleus, incus and stapes, more commonly known as the hammer, anvil and stirrup.

P

pair annihilation
when matter (such as an electron) collides with its corresponding antimatter (such as a positron), both particles are annihilated, and 2 gamma rays with the same energy but with a direction at 180^0 to each other are produced. This is called pair annihilation.

pair production
particle–antiparticle pairs can also be produced when a gamma ray with sufficient energy passes close by a nucleus. The process is the reverse of annihilation and is called pair production.

parallax
the apparent displacement of an object due to the motion of the observer.

parsec
a line of length1 AU subtends an angle of 1 arcsecond (one second of arc /4.8 × 10^{-6} rad) at a distance of one parsec.

Pauli exclusion principle
states that an orbital can only contain a maximum of two electrons and when the 2 electrons occupy an orbital they have opposite spin.

peak current
an alternating current varies sinusoidally and the maximum current called the peak current.

peat
a brownish material that looks like wood. Although it can be burnt as a fuel, it contains a lot of water, and is very smoky when burnt. Under pressure and over time it will be converted to other forms of coal.

percentage uncertainty
is the relative uncertainty multiplied by 100 to produce a percentage.

period
the time taken for an oscillating system to make one complete oscillation.

periodicity
repetition of motion both in space and in time

phase change
a substance can undergo changes of state or phase changes at different temperatures. Pure substances (elements and compounds) have definite melting and boiling points which are characteristic of the particular pure substance being examined.

phase difference
the time interval or phase angle by which one wave leads or lags another.

photo-electric effect
The emission of electrons from a metal surface that is illuminated with light above a certain frequency

photoelectric work function
The minimum energy ϕ required to remove an electron from the surface of a metal by photo-emission. It is related to the threshold frequency by $\phi = hf_0$.

photon
The existence of the photon was postulated by Einstein in 1905 as being a quantum of electromagnetic energy, regarded as a discrete particle having zero mass, no electric charge, and an indefinitely long lifetime. The energy E of a photon associated with light of frequency f is given by the Planck equation $E = hf$.

photopic vision
cones are responsible for photopic vision or high light-level vision, that is, colour vision under normal light conditions during the day. The pigments of the cones are of three types – long wavelength red, medium wavelength green and short wavelength blue.

photovoltaic devices
use the photoelectric effect. Photons from radiant energy excite electrons in a doped semi-conducting material such as silicon or germanium, and the element becomes conducting allowing electrons to flow in an external circuit to produce electrical energy.

physical half-life (T_R)
of a radioactive nuclide is the time taken for half the nuclei present to disintegrate radioactively.

pixels
the smallest element of an image on a LCD or CCD

Planck constant
Max Planck postulated that energy associated with oscillating atoms is proportional to the frequency of oscillation of the atom. The constant (h) relates the energy (E) of a photon to its associated frequency (f).
($E = hf$) (h = 6.2660693 × 10^{-34} J s)

plasma
a super heated gas.

plasma confinement
plasma has to be confined for 1 second with a density of about 500 trillion atoms per cubic centimetre. Because fusion is not a chain reaction, thes temperature and density conditions have to be maintained for future fusions to occur.

polarimeter
essentially a tube that is bounded at both ends with polarizing materials.

polarization
the rotation of the plane of vibration of the electric vector of an electromagnetic wave.

pole (P)
central point of the refracting surface.

pollutants
substances that have undesirable effects on living things and property. Air pollution occurs when these pollutants are introduced into the atmosphere.

population inversion
in the ruby laser, light of energy equivalent to 2.25 eV is absorbed from the flash tube, and this raises the electrons of chromium from the ground state E_1 to an excited state E_3. These electrons quickly undergo spontaneous emission and fall to level E_2 known as the metastable energy state. If the incident radiation from the flash tube is intense enough more electrons are transferred to the E_2 energy level than remain in the ground state – a condition known as population inversion.

positron
a positively charged electron

potential divider
a device that produces the required voltage for a component from a larger voltage.

potential energy
see elastic potential energy, electric potential energy and gravitational potential energy

potential gradient
the rate of change of potential ΔV at a point with respect to distance Δx in the direction in which the change is maximum is called the potential gradient.

power
the rate of working

power of a convex lens (*P*)
is the reciprocal of the focal length. It is a measure of the strength of a lens as used by optometrists and opthalmologists.

power stations
usually rely on thermal energy, gravitational potential energy or wind power to supply the kinetic energy to rotate a turbine. The turbine contains blades that are made to rotate by the force of water, gas, steam or wind. As the turbine rotates, it turns the shaft of a generator. The electrical energy can be produced by rotating coils in a magnetic field.

precision
is an indication of the agreement among a number of measurements made in the same way indicated by the absolute error. A precise experiment has a low random error.

preferential absorption
the phenomenon in which certain crystals only transmit the vertical or horizontal component of the electric vector of an electromagnetic wave.

pressure
it is defined as the force exerted over an area. The SI unit of pressure is the pascal (Pa).

principal axis
line that passes through the centre of curvature and the centre of the refracting surface.

principal focal plane
the plane that passes through the principal focus and is perpendicular to the principal axis.

principal focus (*F*)
point through which rays parallel and close to the principal axis pass after refraction if the lens is convex, or appear to come from if the lens is concave.

principle of superposition
the principle of superposition as applied to wave motion states the displacement at a point where two or more wave meet is the vector sum of the individual displacements of each wave at that point.

proper length
the length of an object as measured by an observer at rest with respect to the object

proper time
the time interval between two events as measured by an observer that sees the events take place at the same point in space.

proton number
the number of protons in a nucleus

protostar
a stage in the formation of a star in which the star is self-luminous but in which nuclear fusion as not yet started.

public switched telephone network (PSTN)
land based telephone exchange

pulsar(s)
a pulsating radio source believed to be a rapidly rotating neutron star.

pulse oximetry
a non-invasive technique used to monitor the oxygen content of haemoglobin.

pump storage systems
used in off-peak electicity demand periods. The water is pumped from low resevoirs to higher resevoirs during this period.

Q

quality
of an X-ray beam is a term used to describe its penetrating power.

quality factor
this is approximately equal in value to the number of oscillations that occur before all the energy of an oscillator is dissipated.

quantum
A discrete packet of energy associated with electromagnetic radiation. (see "photon"). Literally from the Latin "how much".

quantum mechanics
The theory proposed in 1926/7 that replaced Newtonian physics.

quantum numbers
the different states in which an electron can exist are determined by four quantum numbers: principal, orbital, magnetic and spin

quark confinement
the property that quarks are always found in groups that are colourless is called quark confinement.

quarks
with a size of less than 10^{-18} m can never be found in isolation as they are trapped inside other composite particles called hadrons of which the proton, the neutron and mesons are examples.

quasars
very distant and very luminous stellar like objects.

R

r.f (radio frequency) amplifier
an amplifier that amplifies signals in the radio frequency range (several kHz to about 100 Mhz)

radiation
the energy produced by a source because of its temperature that travels as electromagnetic waves. It does not need the presence of matter for its transfer.

radiation shielding
ensures the safety of personnel working inside and around the reactor from suffering the ill effects of radiation exposure. There are usually two shields: several metres of high-density concrete to protect the walls of the reactor core from radiation leakage and to help reflect neutrons back into the core and a biological shield to protect personnel made of several centimetres of high density concrete.

radioactive decay
The spontaneous emission by the nuclei of certain atoms, of radiation in the form of alpha particles or beta particles and/or gamma radiation. The decay process cannot be controlled by chemical and physical means.

radioactivity
see natural radioactivity

radius of curvature (*R*)
the radius of the sphere from which the lens is made.

random uncertainties
are due to variations in the performance of the instrument and the operator. Even when systematic errors have been allowed for, there exists error.

rank advance
as peat became buried beneath more plant matter, the pressure and temperature increased and the water was squeezed out of it. As the material became compacted the peat is converted to lignite, then to sub-bituminous coal and finally bituminous coal. At each stage in the rank advance, the coal has a higher carbon content and a higher energy content per unit mass.

rarefaction
in a sound wave this refers to regions of minimum pressure.

Rayleigh criterion
the images of two sources will be just be resolved by an image forming system if the central maximum of one diffraction pattern image coincides with the first minima of the other diffraction pattern image.

real image
an image that can be seen on a screen that has been put at the point where the rays intersect at a single point.

red giant star
An evolutionary phase of main sequence stars usually with mass less than about $4M_{Sun}$ characterized by low temperature and high luminosity.

red-shift
the Doppler shift of light observed from receding objects.

reflection
occurs when a wave is incident at a boundary between two different media and results in some of the energy of the wave being returned into the medium in which it is travelling before incidence.

refraction
occurs when a wave is incident at a boundary between two different media and results in some of the energy of the incident wave being transmitted across the boundary. If the wavefronts are not parallel to the boundary, the direction of travel of the wave is changed.

refractive index (*n*)
This is defined using the angle of incidence of light in a vacuum and the angle of refraction in the medium whose refractive index is n.

relative uncertainty
equals the absolute uncertainty divided by the measurement. It has no units.

renewable energy source
one that is permanent or one that can be replenished as it is used. Renewable sources being developed for commercial use include solar energy, biomass, wind energy, tidal energy, wave energy, hydro-electric energy and geothermal energy.

reshapers
a device used to re-shape pulses in an optic fibre

resolving power
the minimum angle of resolution

resonance
this occurs when the frequency of forced oscillations is equal to the natural frequency of the system that is being forced.

rest mass-energy
the energy that is equivalent to a body's rest mass

rest mass
the mass of an object as measured by an observer at rest with respect to the object.

rods
photoreceptors that have fast response rates, and are sensitive at low light levels but they are insensitive to colour. There are around 120 million of them.

root-mean-square (r.m.s.) value
the current dissipated in a resistor in an a.c. circuit that varies between I_0 and - I_0 would be equal to a current $I_0 / \sqrt{2}$ dissipated in a d.c circuit. This d.c current is known as r.m.s. equivalent current to the alternating current.

S

Sankey diagram
in a Sankey diagram, the thickness of each arrow gives an indication of the scale of each energy transformation. The total energy before the energy transfer is equal to the total energy after the transfer otherwise the Law of conservation of energy would be violated.

scalar
a quantity that has only magnitude

scattering
the deflection of EM radiation from its original path due to its collisions with particles in a medium.

Schmitt trigger
a circuit designed to re-shape digital electrical signals

scientific notation
expressing numbers to the power of ten

scotopic vision
rods are responsible for scotopic vision which is the ability to see at low light levels or vision "in the dark" or light levels below 0.034 candela per square metre (-0.034 c dm^{-2}). They do not mediate colour and are sometimes termed "colour blind". Because they do not mediate colour, they are said to have low spatial resolution (acuity).

second
the time for 9 192 631 770 vibrations of the cesium-133 atom.

second law of thermodynamics
implies that thermal energy cannot spontaneously transfer from a region of low temperature to a region of high temperature.

sensors
an input transducers that allows for the transfer of energy from one form to another.

SI unit
an international system of units including the metric system. SI units are those of Le Système International d'Unités adopted in 1960 by the Conférence Générale des Poids et Mesures.

sideband frequencies
a modulated wave consists of the carrier wave plus two waves one of frequency (f_c - f_s) and the other of frequency (f_c + f_s). The frequencies are called the sideband frequencies.

signal wave
the name given to the wave that carries information

significant figures/digits
(sf/sd) are those digits that are known with certainty followed by the first digit which is uncertain.

simple harmonic motion
occurs when the force acting on a system is directed towards the equilibrium position of the system and is proportional to the displacement of the system from equilibrium

Snell's law
is usually applied to light waves and states that when light travels from one medium into another

solar constant
the average radiant power radiated to an area placed perpendicular to the outer surface of the earth's atmosphere while the earth is at its mean distance from the Sun.

SONAR (sound navigation and ranging)
the use of sound waves to detect and estimate the range of submerged objects. In the 1930s it had its applications in medical therapy.

sound intensity
the average power per unit area of a sound wave that is incident perpendicular to the direction of propagation is called the sound intensity. The units of sound intensity are watts per square metre, W m^{-2}. As the sound intensity spreads out from its source, the intensity I is reduced as the inverse square of the distance d from the source.

source independence
the name given to the phenomenon in which audio and visual digital data can be transmitted using the same channel.

space-time
a coordinate system consisting of three dimensions of space and one of time

space–time diagram
the representation of the motion of an object in space-time

specific heat
see specific heat capacity.

specific heat capacity
is the heat capacity per unit mass. It is defined as the quantity of thermal energy required to raise the temperature of one kilogram of a substance by one degree Kelvin.

spectral classes
a classification of stars according to their observed spectrum

speed
see average speed and instantaneous speed

spherical aberration
occurs because the rays that refract at the outer edges of a lens will have a different focal length to those rays that refract near the principal focus. To put it another way, spherical aberration occurs because the rays incident near the edges of a converging lens are refracted more than the paraxial rays

spring constant
the constant k relating the extension x of a spring to the force F causing the extension $F = kx$

standard form
see scientific notation.

standard notation
see scientific notation.

stationary waves
sometimes also referred to as standing waves. Waves in which there is no propagation of energy between points along the wave. The amplitude of a stationary wave varies with position along the wave.

steam engine
an example of external combustion engines. The fuel is burnt outside the engine and the thermal energy is transferred to a piston or a turbine chamber by means of steam.

Stefan's law
the total area under a spectral emission curve for a certain temperature T represents the total energy radiated per metre^2 per unit time E and for that assigned temperature it has been found to be directly proportional to the fourth power T^4.

Stefan-Boltzmann law
A law that relates the luminosity of an object to its absolute temperature and area

Stellar cluster
this is a number of stars that were all created about the same time and that is held together in a group by gravitational attraction.

stellar interferometer
a radio telescope that consists of two or more parabolic receiving dishes

step-down transformer
a transformer that if N_s is less than N_p it will be a step-down transformer.

step-index fibre
an optic fibre in which the refractive index of the different materials comprising the fibre change by discrete amounts.

step-up transformer
a transformer that if N_s is greater than N_p then the transformer is a step-up transformer.

strain viewer
a device that use polarized light to view the stress produced in materials subject to strain. It consists of two polaroids with the material under strain placed between them.

string theory
an alternative to quantum theory that proposes that each fundamental particle consists of an oscillating string of a small size compared with the proton. Rather than talking about mathematical particles, string theory talks about oscillating strings that are lines or loops of about 10^{-35} m, and membranes in small dimensions other than the three dimensions that we presently use.

strong nuclear interaction
the short range force of attraction between nucleons.

super red-giant star
an evolutionary phase of main sequence stars usually with mass greater than about $8M_{Sun}$ characterized by low temperature and very high luminosity

surface heat capacity C_s
the energy required to raise the temperature of a unit area of a planet's surface by one degree Kelvin and is measured in J m^{-2} K^{-1}.

synchrotrons
the most powerful members of the accelerator family

system
any object or set of objects that is being investigated. The surroundings will then be everything in the Universe apart from the system.

systematic error
causes a random set of measurements to be spread about a value rather than being spread about the accepted value. It is a system or instrument error.

T

temperature
a scalar quantity that gives an indication of the degree of hotness or coldness of a body. Alternatively, temperature is a macroscopic property that measures the average kinetic energy of particles on a defined scale such as the Celsius or Kelvin scales. At the microscopic level, temperature is regarded as the measure of the average random kinetic energy per molecule associated with its movements.

tension force
this arises when a system is subjected to two equal and opposite forces.

terminal velocity
the velocity reached when the magnitude of the frictional force acting on a body is equal to the magnitude of the driving force.

thermal (heat) capacity
the change in thermal energy for a given change in temperature.

thermal energy (heat)
If a system and its surroundings are at different temperatures and the system undergoes a process, the energy transferred by non-mechanical means is referred to as thermal energy (heat). It is measured in joules.

thermistors
resistors that change resistance with temperature (word derived from thermal resistors).

thermodynamic cycle
a process in which the system is returned to the same state from which it started. That is, the initial and final states are the same in the cyclic process.

thermodynamic engine
device that transforms thermal energy to mechanical energy (work) as in an engine, or mechanical energy to thermal energy such as in refrigeration and air-conditioning systems.

thermodynamics
the name given to the study of processes in which thermal energy is transferred as heat and as work.

three phase power
There are 3 conductors on a transmission line to maximize the amount of power that can be generated. Each high voltage circuit has three phases. The generators at the power station supplying the power system have their coils connected through terminals at 120° to each other. When each generator at the power station rotates through a full rotation, the voltages and the currents rise and fall in each terminal in a synchronized manner.

threshold frequency
The frequency below which photoelectric emission will not take place.

threshold intensity of hearing
the minimum detectable intensity for a given frequency is called the threshold intensity of hearing.

time dilation
the slowing of time as observed by an inertial observer who assumes to be at rest with respect to another, moving inertial reference system

total internal reflection
reflection in which all the light incident at a boundary between two media undergoes reflection

transmission rate
another name for bit-rate

transmutation
see artificial transmutation

transverse waves
in these types of wave the source that produces the wave vibrates at right angles to the direction of travel of the wave i.e. the direction in which the energy carried by the wave is propagated. The particles of the medium through which the wave travels vibrate at right angles to the direction of travel of the wave (direction of energy propagation).

travelling wave
a wave that propagates energy

trough
the minimum displacement of a medium through which a wave travels.

tuning circuit
a circuit designed to respond to signals of a certain frequency

U

Uncertainty principle
See 'Heisenberg Uncertainty Principle'

unit of current
is the coulomb per second C s^{-1} and this unit is called the ampere (A).

V

variable
a quantity that varies when another quantity is changed. A variable can be an independent variable, a dependent variable or a controlled variable. An independent variable is altered while the dependent variable is measured. Controlled variables are the other variables that may be present but are kept constant.

vector
a quantity that has both magnitude and direction

vector resolution
giving the x and y components of a vector.

velocity
see average velocity and instantaneous velocity

virtual earth
a point in a circuit that is effectively at earth potential (zero volts)

virtual image
an image that appears to come from a single point when rays are extrapolated to that point.

virtual particle
a particle that cannot be observed during an interaction. A virtual photon is said to be the carrier of the electromagnetic force.

voltmeter
is used to measure the voltage drop across part of an electric circuit and is always connected in parallel.

W

W^+, W^- and Z_0
the exchange particles involved in the weak nuclear interaction.

wave number
the number of waves per centimeter (cm^{-1})

wave speed
is the speed with which energy is carried in the medium by the wave. A very important fact is that wave speed depends only on the nature and properties of the medium.

wavelength
is the distance along the medium between two successive particles that have the same displacement

wave-mechanics
Another name for quantum mechanics.

weight
another term for the force of gravity acting on an object

weightlessness
if the weight of an object is defined in terms of a 'weighing' process such as the reading on a set of bathroom scales, which in effect measures the contact force between the object and the scales, then objects in free fall are weightless.

Wien Displacement Law
a law that relates the maximum wavelength in the blackbody spectrum of an object to the absolute temperature of the object.

work
the product of force and displacement in the direction of the force.