

Glossary

A

acceleration change of velocity per unit time.

acceleration of free fall acceleration of an object acted on only by the force of gravity.

accurate a measurement that is obtained, using accurately-calibrated instruments correctly, is said to be accurate.

accuracy a measurement is considered accurate if it is judged to be close to the true value.

alpha radiation particles that each consist of two protons and two neutrons.

amplitude maximum displacement of a vibrating particle; for a transverse wave, it is the distance from the middle to the peak of the wave.

annihilation when a particle and its antiparticle meet, they destroy each other and become radiation.

antibaryon a hadron consisting of three antiquarks.

antimatter *antiparticles* that each have the same rest mass and, if charged, have equal and opposite charge to the corresponding particle. See *annihilation* and *pair production*.

antimuon antiparticle of the muon; see *muon*.

antineutrino the antiparticle of the *neutrino*.

antinode fixed point in a stationary wave pattern where the amplitude is a maximum.

antiparticle There is an antiparticle for every type of particle. A particle and its corresponding antiparticle have equal rest mass and, if charged, equal and opposite charge.

antiquark antiparticle of a quark.

atomic number Z the number of protons in the nucleus of an atom.

B

baryon a hadron consisting of three quarks.

base units the units that define the SI system (e.g., the metre, the kilogram, the second, the ampere).

beta radiation β^- particles are fast moving electrons emitted by unstable neutron-rich nuclei; β^+ particles are fast moving *positrons* emitted by unstable proton-rich nuclei.

braking distance the distance travelled by a vehicle in the time taken to stop it.

breaking stress see *ultimate tensile stress*.

brittle snaps without stretching or bending when subject to stress.

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C

centre of mass the centre of mass of a body is the point through which a single force on the body has no turning effect.

charge carriers charged particles that move through a substance when a pd is applied across it.

circuit rule for current (Kirchhoff's first law)

1. The current passing through two or more components in series is the same through each component.
2. At a junction, the total current in = the total current out.

circuit rules for pd (Kirchhoff's second law)

1. For two or more components in series, the total pd across all the components is equal to the sum of the pds across each component.
2. The sum of the emfs round a complete loop in a circuit = the sum of the pds round the loop.

coherent two sources of waves are coherent if they emit waves with a constant phase difference.

conservation rules conservation of energy, momentum, charge, *baryon number* and *lepton numbers* applies to all particle interactions. Conservation of *strangeness* applies to strong interactions only.

couple pair of equal and opposite forces acting on a body but not along the same line.

critical angle the angle of incidence of a light ray must exceed the critical angle *for total internal reflection* to occur.

critical temperature of a superconducting material temperature at and below which its resistivity is zero.

cycle interval for a vibrating particle (or a wave) from a certain displacement and velocity to the next time the particle (or the next particle) that has the same displacement and velocity.

D

de Broglie hypothesis matter particles have a wave-like nature characterised by the de Broglie wavelength.

de Broglie wavelength the wavelength of a matter particle $= \frac{h}{p}$, where p is the momentum of the particle.

de-excitation process in which an atom loses energy by photon emission, as a result of an electron inside an atom moving from an outer shell to an inner shell.

density of a substance mass per unit volume of the substance

diffraction spreading of waves on passing through a gap or near an edge.

diffraction grating a plate with many closely-ruled parallel slits on it.

dispersion splitting of a beam of white light by a glass prism into colours.

displacement distance in a given direction.

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drag force the force of fluid resistance on an object moving through the fluid.

ductile stretches easily without breaking.

E

efficiency the ratio of useful energy transferred (or the useful work done) by a machine or device to the energy supplied to it.

The ratio of the machine's outward power to its input power.

effort the force applied to a machine to make it move.

elastic limit point beyond which a wire is permanently stretched.

elasticity property of a solid that enables it to regain its shape after it has been deformed or distorted.

electrolysis process of electrical conduction in a solution or molten compound due to ions moving to the oppositely charged electrode.

electrolyte a solution or molten compound that conducts electricity.

electromagnetic interaction (or force) interaction (or force) between two charged objects.

electromagnetic radiation see *electromagnetic wave*.

electromagnetic wave a wavepacket or photon consisting of transverse electric and magnetic waves in phase and at right angles to each other.

electromotive force (emf) the amount of electrical energy per unit charge produced inside a source of electrical energy.

electron capture process in which an inner-shell electron of an atom is captured by the nucleus.

electron volt amount of energy equal to 1.6×10^{-19} J defined as the work done when an electron is moved through a pd of 1 V.

endoscope optical fibre device used to see inside cavities.

energy the capacity to do work; see *work*.

energy levels the energy of an electron in an electron shell of an atom.

equilibrium state of an object when at rest or in uniform motion.

error bar representation of an uncertainty on a graph.

error of measurement difference between a measured value and the true value. Errors can include *systematic* (including *zero error*) and *random*.

excitation process in which an atom absorbs energy without becoming ionised as a result of an electron inside an atom moving from an inner shell to an outer shell.

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F

first harmonic Pattern of stationary waves on a string when it vibrates at its lowest possible frequency.

fluorescence glow of light from a substance exposed to ultraviolet radiation; the atoms de-excite in stages and emit visible photons in the process.

force any interaction that can change the velocity of an object.

free body force diagram a diagram of an object showing only the forces acting on the object.

frequency the number of cycles of a wave that pass a point per second.

friction force opposing the motion of a surface that moves or tries to move across another surface.

fundamental mode of vibration see *first harmonic*.

G

gamma radiation high-energy photons emitted by unstable nuclei or produced in particle annihilations.

gravitational field strength force of gravity per unit mass on a small object.

ground state lowest energy state of an atom.

H

hadron particles and antiparticles that can interact through the strong interaction.

Hooke's law the extension of a spring is proportional to the force needed to extend it.

I

inertia resistance of an object to change of its motion.

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

internal resistance resistance inside a source of electrical energy; the loss of pd per unit current in the source when current passes through it.

ion a charged atom.

ionisation process of creating ions.

isotopes atoms of an element with different numbers of neutrons and the same number of protons.

K

kaon (or K meson) a *meson* that consists of a *strange quark* or *antiquark* and another quark or antiquark.

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kinetic energy the energy of an object due to its motion.

L

laser device that produces a parallel coherent beam of monochromatic light.

lepton electrons, positrons, muons and antimuons, neutrinos, and their antiparticles are classified as leptons because they cannot interact through the strong interaction. They interact through the weak interaction and, in the case of electrons and positrons, through the electromagnetic interaction.

lepton number a lepton number is assigned to every lepton (+1) and antilepton (-1), on the basis that the total lepton number for each branch of the lepton family is always conserved.

light-dependent resistor resistor which is designed to have a resistance that changes with light intensity.

limit of proportionality the limit beyond which, when a wire or a spring is stretched, its extension is no longer proportional to the force that stretches it.

linear two quantities are said to have a linear relationship if the change of one quantity is proportional to the change of the other.

load the force to be overcome by a machine when it shifts or raises an object.

longitudinal waves waves with a direction of vibration parallel to the direction of propagation of the waves.

M

mass number see *nucleon number*

mass measure of the inertia or resistance to change of motion of an object.

matter waves the wave-like behaviour of particles of matter.

meson a hadron consisting of a quark and an antiquark.

modal dispersion the lengthening of a light pulse as it travels along an optical fibre, due to rays that repeatedly undergo total internal reflection having to travel a longer distance than rays that undergo fewer total internal reflections.

moment of a force about a point force \times perpendicular distance from the line of action of the force to the point.

momentum mass \times velocity.

motive force the force that drives a vehicle.

muon a *lepton* that is negatively charged and has a greater rest mass than the electron.

N

negative temperature coefficient the resistance of a semiconductor decreases when its temperature is increased.

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neutrino uncharged *lepton* with a very low rest mass compared with the electron.

neutrino types (or 'branches') there are three types of neutrinos, the electron neutrino, the muon neutrino, and the tau neutrino. This specification only requires knowledge of the electron neutrino and the muon neutrino branches (and their antiparticles) of the lepton 'family'.

Newton's first law of motion an object remains at rest or in uniform motion unless acted on by a resultant force.

Newton's second law of motion the rate of change of momentum of an object is proportional to the resultant force (F) on it. Newton's 2nd law may be written as $F = (\Delta mv)/\Delta t$. For constant mass, this equation becomes $F = ma$ where acceleration $a = (\Delta v/\Delta t)$

node fixed point in a stationary wave pattern where the amplitude is zero.

nucleon a neutron or proton in the nucleus.

nucleon number A the number of neutrons and protons in a nucleus; also referred to as *mass number*.

nuclide a type of nucleus with a particular number of protons and neutrons.

O

Ohm's law the pd across a metallic conductor is proportional to the current, provided the physical conditions do not change.

optical fibre a thin flexible transparent fibre used to carry light pulses from one end to the other.

P

pair production when a gamma photon changes into a particle and an antiparticle.

pascal unit of pressure or stress equal to 1 N m^{-2} .

path difference the difference in distances from two coherent sources to an interference fringe.

period time for one complete cycle of a wave to pass a point.

phase difference the fraction of a cycle between the vibrations of two vibrating particles, measured either in radians or degrees.

photoelectric effect emission of electrons from a metal surface when the surface is illuminated by light of frequency greater than a minimum value known as the *threshold frequency*.

photon packet or 'quantum' of electromagnetic waves.

pion (or π meson) a *meson* that consists of an up or down *quark* and an up or down *antiquark*.

plane-polarised waves transverse waves that vibrate in one plane only.

plastic deformation deformation of a solid beyond its elastic limit.

positive temperature coefficient the resistance of a metal increases when its temperature is increased.

positron *antiparticle* of the electron.

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potential difference work done or energy transfer per unit charge between two points when charge moves from one point to the other.

potential divider two or more resistors in series connected to a source of pd.

potential energy the energy of an object due to its position.

power rate of transfer of energy.

precision of a measurement precise measurements are ones in which there is very little spread about the mean value. Precision depends only on the extent of random error and it gives no indication of how close the results are to the true value.

precision of an instrument the smallest non-zero reading that can be measured, also sometimes referred to as the instrument sensitivity or resolution.

pressure force per unit area acting on a surface perpendicular to the surface.

principle of conservation of energy energy cannot be created or destroyed.

principle of moments for an object in equilibrium, the sum of the clockwise moments about any point = the sum of the anticlockwise moments about that point.

probable error estimate of the *uncertainty* of a measurement.

progressive waves waves which travel through a substance or through space if electromagnetic.

projectile a projected object in motion acted on only by the force of gravity.

proton number see *atomic number*.

Q

quark protons and neutrons and other hadrons consist of quarks. There are six types of quarks, the up quark, the down quark, the strange quark, the charmed quark, the top quark and the bottom quark. This specification only requires knowledge of the up, down, and strange quarks and their antiquarks.

quark model (or standard model) a quark can join with an antiquark to form a *meson* or with two other quarks to form a *baryon*. An antiquark can join with two other antiquarks to form an *antibaryon*.

R

radian measure of an angle defined such that 2π radians = 360° .

random error error of measurement due to results varying in an unpredictable way from one measurement to the next. They are present when any measurement is made, and cannot be corrected. The effect of random errors can be reduced by making more measurements and calculating a new mean.

range of a set of a readings the range of a set of readings of the same measurement is the difference between the minimum and the maximum reading.

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range of an instrument the difference between the minimum and the maximum reading that can be obtained using the instrument.

refraction change of direction of a wave when it crosses a boundary where its speed changes.

refractive index speed of light in free space / speed of light in the substance.

resistance $\text{pd}/\text{current}$.

resistivity resistance per unit length \times area of cross-section.

rest energy energy due to rest mass m_0 , equal to $m_0 c^2$, where c is the speed of light in free space.

S

scalar a physical quantity with magnitude only.

semiconductor a substance in which the number of charge carriers increases when the temperature is raised.

sensitivity of an instrument the output reading per unit input quantity.

SI system the scientific system of units.

specific charge charge/mass value of a charged particle.

spectrometer instrument used to measure light wavelengths very accurately.

speed change of distance per unit time.

stationary waves wave pattern with nodes and antinodes formed when two or more progressive waves of the same frequency and amplitude pass through each other.

stiffness constant the force per unit extension needed to extend a wire or a spring.

stopping distance *thinking distance + braking distance*.

stopping potential the minimum potential that needs to be applied to a metal plate to attract all the photoelectrons emitted from its surface back to the surface.

strain extension per unit length of a solid when deformed.

strangeness number a strangeness number is assigned to every particle and antiparticle on the basis that strangeness is always conserved in the strong interaction, but not in a weak interaction or a decay involving a strange quark or antiquark.

stress force per unit area of cross-section in a solid perpendicular to the cross-section.

strong interaction interaction between two hadrons.

strong nuclear force attractive force between nucleons that holds the nucleons in the nucleus.

superconductor a material that has zero electrical resistance.

superposition the effect of two waves adding together when they meet.

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systematic errors cause readings to differ from the true value by a consistent amount each time a measurement is made. Sources of systematic errors can include the environment, methods of observation, or instruments used.

T

terminal pd the potential difference across the terminals of a power supply.

terminal speed the maximum speed reached by an object when the drag force on it is equal and opposite to the force causing the motion of the object.

thermistor resistor which is designed to have a resistance that changes with temperature.

thinking distance the distance travelled by a vehicle in the time it takes the driver to react.

threshold frequency minimum frequency of light that can cause *photoelectric effect*.

total internal reflection a light ray travelling in a substance is totally internally reflected at a boundary with a substance of lower refractive index, if the angle of incidence is greater than a certain value known as the *critical angle*.

transverse waves waves with a direction of vibration perpendicular to the direction of propagation of the waves.

types of light spectra continuous spectrum – continuous range of colours corresponding to a continuous range of wavelengths, line emission spectrum – characteristic coloured vertical lines, each corresponding to a certain wavelength, line absorption spectrum – dark vertical lines against a continuous range of colours, each line corresponding to a certain wavelength.

U

ultimate tensile stress tensile stress needed to break a solid material.

uncertainty the interval within which the true value can be expected to lie, with a given level of confidence or probability.

useful energy energy transferred to where it is wanted when it is wanted.

V

vector a physical quantity with magnitude and direction.

velocity change of displacement per unit time.

virtual photon carrier of the electromagnetic force; a photon exchanged between two charged particles when they interact.

W

W boson carrier of the weak nuclear force; W bosons have non-zero rest mass and may be positive or negative.

wave – particle duality matter particles have a wave-like nature as well as a particle-like nature; photons have a particle-like nature as well as a wave-like nature.

wavefronts lines of constant phase (e.g., wavecrests).

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wavelength the least distance between two adjacent vibrating particles with the same displacement and velocity at the same time (e.g., distance between two adjacent wave peaks).

weak interaction interaction between two leptons.

weak nuclear force force responsible for beta decay.

weight the force of gravity acting on an object.

work force \times distance moved in the direction of the force.

work function minimum amount of energy needed by an electron to escape from a metal surface.

Y

yield point point at which the stress in a wire suddenly drops when the wire is subjected to increasing strain.

Young's fringes parallel bright and dark fringes observed when light from a narrow slit passes through two closely spaced slits.

Young modulus stress/strain (assuming the limit of proportionality has not been exceeded).

Z

zero error any indication that a measuring system gives a false reading when the true value of a measured quantity is zero. A zero error may result in a systematic uncertainty.