牛津英语百科分类词典系列

Oxford

DICTIONARY OF PHYSICS

牛津物理学词典

上海外语教育出版社
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ALAN ISAACS

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出版说明

随着改革开放的不断深入以及国际交流的日趋广泛，外语学习已经不仅仅局限于语言技能的培养。通过英语获取专业知识、提高专业水平、跟踪学科的最新发展已经成为时代的要求。因此，目前国内急需一批用英语编纂的专业词典。

牛津英语百科分类词典系列是由牛津大学出版社组织编纂的一套工具书。该系列涉及语言学、文学、文化、艺术、社会学、数学、物理学、化学、生物学、医学、食品与营养、计算机等社会科学和自然科学门类近百种，均由造诣很深、经验丰富的专家撰写。作为第一批，我们从中精选了 52 本，以满足国内读者的需要。词典用浅显的英语，精确地解释了常用的专业词汇，充分体现了牛津大学出版社在出版工具书方面严谨的传统。

该系列词典可作为大专院校各专业的学生以及专业技术人员学习专业知识、提高专业英语能力的参考书。

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Preface

This dictionary is derived from the *Concise Science Dictionary*, first published by Oxford University Press in 1984 (third edition, 1996). It consists of all the entries relating to physics in this dictionary, together with some of those entries relating to astronomy that are required for an understanding of astrophysics and many entries that relate to physical chemistry. It also includes a selection of the words used in mathematics that are relevant to physics, as well as the key words in metal science, computing, and electronics. For this third edition a number of words from quantum field physics and statistical mechanics have been added. Cosmology and particle physics have been updated and a number of general entries have been expanded. The more chemical aspects of physical chemistry and the chemistry itself will be found in *A Dictionary of Chemistry*, which is a companion volume to this dictionary.

An asterisk placed before a word used in an entry indicates that this word can be looked up in the dictionary and will provide further explanation or clarification. However, not every word that appears in the dictionary has an asterisk placed before it. Some entries simply refer the reader to another entry, indicating either that they are synonyms or abbreviations or that they are most conveniently explained in one of the dictionary's longer articles. Synonyms and abbreviations are usually placed within brackets immediately after the headword. Terms that are explained within an entry are highlighted by being printed in italic type.

A Dictionary of Biology contains the biophysical entries from the *Concise Science Dictionary* together with the entries relating to biology.

SI units are used throughout this book and its companion volumes.

1996 **A.I.**

Editor

Alan Isaacs BSc, PhD, DIC

Advisers

B. S. Beckett BSc, BPhil, MA (Ed)
R. A. Hands BSc
Michael Lewis MA

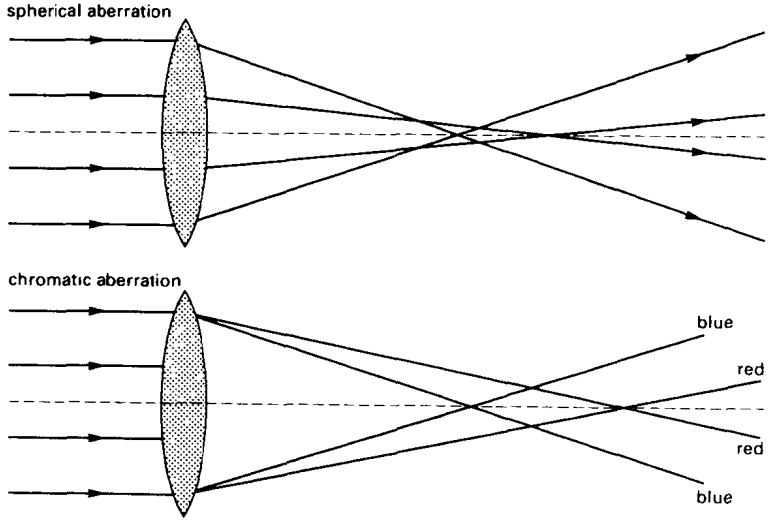
Contributors

H. M. Clarke MA, MSc
Derek Cooper PhD, FRIC
D. E. Edwards BSc, MSc
Richard Rennie PhD, MSc, BSc
David Eric Ward BSc, MSc, PhD

A

ab- A prefix attached to the name of a practical electrical unit to provide a name for a unit in the *electromagnetic system of units, e.g. abampere, abcoulomb, abvolt. The prefix is an abbreviation of the word 'absolute' as this system is also known as the *absolute system*. *Compare* **stat-**. In modern practice both absolute and electrostatic units have been replaced by *SI units.

Abelian group *See* **group.**



Aberration

aberration **1.** ***(in optics)*** A defect in the image formed by a lens or curved mirror. In *chromatic aberration* the image formed by a lens (but not a mirror) has coloured fringes as a result of the different extent to which light of different colours is refracted by glass. It is corrected by using an *achromatic lens. In *spherical aberration*, the rays from the object come to a focus in slightly different positions as a result of the curvature of the lens or mirror. For a mirror receiving light strictly parallel with its axis, this can be corrected by using a parabolic surface rather than a spherical surface. Spherical aberration in lenses is minimized by making both surfaces contribute equally to the ray deviations, and can (though with reduced image brightness) be reduced by the use of diaphragms to let light

pass only through the centre part of the lens. *See also* **astigmatism; coma.** **2.** ***(in astronomy)*** The apparent displacement in the position of a star as a result of the earth's motion round the sun. Light appears to come from a point that is slightly displaced in the direction of the earth's motion. The angular displacement $\alpha = v/c$, where v is the earth's orbital velocity and c is the speed of light.

abscissa *See* **Cartesian coordinates.**

absolute **1.** Not dependent on or relative to anything else, e.g. *absolute zero. **2.** Denoting a temperature measured on an *absolute scale*, a scale of temperature based on absolute zero. The usual absolute scale now is that of thermodynamic *temperature; its unit, the kelvin, was formerly called the degree absolute (°A) and is the same size as the degree Celsius. In British engineering practice an absolute scale with Fahrenheit-size degrees has been used: this is the Rankine scale.

absolute expansivity *See* **expansivity.**

absolute humidity *See* **humidity.**

absolute permittivity *See* **permittivity.**

absolute pitch (perfect pitch) The ability of a person to identify and reproduce a note without reference to a tuned musical instrument.

absolute temperature *See* **absolute; temperature.**

absolute value (modulus) The square root of the sum of the squares of the real numbers in a *complex number, i.e. the absolute value of the complex number $z = x + iy$ is $|z| = \sqrt{(x^2 + y^2)}$.

absolute zero Zero of thermodynamic *temperature (0 kelvin) and the lowest temperature theoretically attainable. It is the temperature at which the kinetic energy of atoms and molecules is minimal. It is equivalent to −273.15°C or −459.67°F. *See also* **zero-point energy; cryogenics.**

absorptance Symbol α. The ratio of the radiant or luminous flux absorbed by a body to the flux falling on it. Formerly called *absorptivity*, the absorptance of a *black body is by definition 1.

absorption **1.** The take-up of a gas by a solid or liquid, or the take up of a liquid by a solid. Absorption differs from *adsorption in that the absorbed substance permeates the bulk of the absorbing substance. **2.** The conversion of the energy of electromagnetic radiation, sound, streams of particles, etc., into other forms of energy on passing through a medium. A beam of light, for instance, passing through a medium, may lose intensity because of two effects: *scattering of light out of the beam, and absorption of photons by atoms or molecules in the medium. When a photon is absorbed, there is a transition to an excited state.

absorption coefficient **1.** ***(in physics)*** *See* **Lambert's laws.** **2.** ***(in***

chemistry) The volume of a given gas, measured at standard temperature and pressure, that will dissolve in unit volume of a given liquid.

absorption spectrum *See* **spectrum**.

absorptivity *See* **absorptance**.

abundance **1.** The ratio of the total mass of a specified element in the earth's crust to the total mass of the earth's crust, often expressed as a percentage. For example, the abundance of aluminium in the earth's crust is about 8%. **2.** The ratio of the number of atoms of a particular isotope of an element to the total number of atoms of all the isotopes present, often expressed as a percentage. For example, the abundance of uranium-235 in natural uranium is 0.71%. This is the *natural abundance*, i.e. the abundance as found in nature before any enrichment has taken place.

a.c. *See* **alternating current**.

acceleration Symbol a. The rate of increase of speed or velocity. It is measured in $m\,s^{-2}$. For a body moving linearly with constant acceleration a from a speed u to a speed v,

$$a = (v - u)/t = (v^2 - u^2)/2s$$

where t is the time taken and s the distance covered.

If the acceleration is not constant it is given by $dv/dt = d^2s/dt^2$. If the motion is not linear the vector character of displacement, velocity, and acceleration must be considered.

acceleration of free fall Symbol g. The acceleration experienced by any massive object falling freely in the earth's gravitational field. Experimentally this is almost constant for all positions near the earth's surface, independent of the nature of the falling body (provided air resistance is eliminated). This is taken to indicate the strict proportionality of *weight (the force causing the acceleration) and *inertial mass, on the basis of *Newton's second law of motion. There is some variation of g with latitude, because of the earth's rotation and because the earth is not completely spherical. The standard value is taken as $9.806\,65\,m\,s^{-2}$. The acceleration of free fall is also called the *acceleration due to gravity*.

accelerator An apparatus for increasing the kinetic energies of charged particles, used for research in nuclear and particle physics. *See* **cyclotron; linear accelerator; synchrocyclotron; synchrotron**.

acceptor A substance that is added as an impurity to a *semiconductor because of its ability to accept electrons from the valence bands, causing p-type conduction by the mobile positive holes left.

acceptor levels Energy levels of an acceptor atom in a *semiconductor, such as aluminium, in silicon. These energy levels are very near the top of the valence band, and therefore cause p-type conduction. *See also* **energy bands**.

accommodation The process by which the focal length of the *lens of

the eye is changed so that clear images of objects at a range of distances are displayed on the retina. In man and some other mammals accommodation is achieved by reflex adjustments in the shape of the lens brought about by relaxation and contraction of muscles within the ciliary body.

accretion disc A disc-shaped rotating mass formed by gravitational attraction. *See* **black hole; neutron star; white dwarf**.

accumulator (secondary cell; storage battery) A type of *voltaic cell or battery that can be recharged by passing a current through it from an external d.c. supply. The charging current, which is passed in the opposite direction to that in which the cell supplies current, reverses the chemical reactions in the cell. The common types are the *lead-acid accumulator and the *nickel-iron and nickel-cadmium accumulators. *See also* **sodium-sulphur cell**.

achromatic lens A lens that corrects for chromatic *aberration by using a combination of two lenses, made of different kinds of glass, such that their *dispersions neutralize each other although their *refractions do not. The aberration can be reduced further by using an *apochromatic lens*, which consists of three or more different kinds of glass.

acoustics 1. The study of sound and sound waves. **2.** The characteristics of a building, especially an auditorium, with regard to its ability to enable speech and music to be heard clearly within it. For this purpose there should be no obtrusive echoes or resonances and the reverberation time should be near the optimum for the hall. Echoes are reduced by avoiding sweeping curved surfaces that could focus the sound and by breaking up large plane surfaces or covering them with sound-absorbing materials. Resonance is avoided by avoiding simple ratios for the main dimensions of the room, so that no one wavelength of sound is a factor of more than one of them. If the reverberation time is too long, speech will sound indistinct and music will be badly articulated, with one note persisting during the next. However, if it is too short, music sounds dead. It is long in a bare room with hard walls, and can be deliberately reduced by carpets, soft furnishings and sound-absorbent ('acoustic') felt. Reverberation times tend to be reduced by the presence of an audience and this must be taken into account in the design of the building.

acoustoelectronic devices (electroacoustic devices) Devices in which electronic signals are converted into acoustic waves. Acoustoelectronic devices are used in constructing *delay lines and also in converting digital data from computers for transmission by telephone lines.

actinic radiation Electromagnetic radiation that is capable of initiating a chemical reaction. The term is used especially of ultraviolet radiation and also to denote radiation that will affect a photographic emulsion.

actinium Symbol Ac. A silvery radioactive metallic element belonging to group 3 (formerly IIIA) of the periodic table; a.n. 89; mass number of most

stable isotope 227 (half-life 21.7 years); m.p. 1050 ± 50°C; b.p. 3200°C (estimated). Actinium-227 occurs in natural uranium to an extent of about 0.715%. Actinium-228 (half-life 6.13 hours) also occurs in nature. There are 22 other artificial isotopes, all radioactive and all with very short half-lives. Its chemistry is similar to that of lanthanum. Its main use is as a source of alpha particles. The element was discovered by A. Debierne in 1899.

actinium series *See* **radioactive series.**

actinoid contraction A smooth decrease in atomic or ionic radius with increasing proton number found in the actinoids.

actinometer Any of various instruments for measuring the intensity of electromagnetic radiation. Recent actinometers use the *photoelectric effect but earlier instruments depended either on the fluorescence produced by the radiation on a screen or on the amount of chemical change induced in some suitable substance.

action at a distance The direct interaction between bodies that are not in physical contact with each other. The concept involves the assumption that the interactions are instantaneous. This assumption is not consistent with the special theory of *relativity, which states that nothing (including interactions) can travel through space faster than the *speed of light in a vacuum. For this reason it is more logical to describe interactions between bodies by *field theories or by the exchange of *virtual particles rather than theories based on action at a distance.

action potential The change in electrical potential that occurs across a cell membrane during the passage of a nerve impulse. As an impulse travels in a wavelike manner along the axon of a nerve, it causes a localized and transient switch in electric potential across the cell membrane from −60 mV (millivolts; the resting potential) to +45 mV. The change in electric potential is caused by an influx of sodium ions. Nervous stimulation of a muscle fibre has a similar effect.

action spectrum A graphical plot of the efficiency of electromagnetic radiation in producing a photochemical reaction against the wavelength of the radiation used. For example, the action spectrum for photosynthesis using light shows a peak in the region 670–700 nm. This corresponds to a maximum absorption in the absorption spectrum of chlorophylls in this region.

activation analysis An analytical technique that can be used to detect most elements when present in a sample in milligram quantities (or less). In *neutron activation analysis* the sample is exposed to a flux of thermal neutrons in a nuclear reactor. Some of these neutrons are captured by nuclides in the sample to form nuclides of the same atomic number but a higher mass number. These newly formed nuclides emit gamma radiation, which can be used to identify the element present by means of a gamma-ray spectrometer. Activation analysis has also been employed using charged particles, such as protons or alpha particles.

active device **1.** An electronic component, such as a transistor, that is capable of amplification. **2.** An artificial *satellite that receives information and retransmits it after amplification. **3.** A radar device that emits microwave radiation and provides information about a distant body by receiving a reflection of this radiation. *Compare* **passive device.**

activity **1.** Symbol a. A thermodynamic function used in place of concentration in equilibrium constants for reactions involving nonideal gases and solutions. For example, in a reaction

$$A \leftrightarrows B + C$$

the true equilibrium constant is given by

$$K = a_B a_C / a_A$$

where a_A, a_B, and a_C are the activities of the components, which function as concentrations (or pressures) corrected for nonideal behaviour. *Activity coefficients* (symbol γ) are defined for gases by $\gamma = a/p$ (where p is pressure) and for solutions by $\gamma = aX$ (where X is the mole fraction). Thus, the equilibrium constant of a gas reaction has the form

$$K_p = \gamma_B p_B \gamma_C p_C / \gamma_A p_A$$

The equilibrium constant of a reaction in solution is

$$K_c = \gamma_B X_B \gamma_C X_C / \gamma_A X_A$$

The activity coefficients thus act as correction factors for the pressures or concentrations. *See* **fugacity.**
2. Symbol A. The number of atoms of a radioactive substance that disintegrate per unit time. The *specific activity* (a) is the activity per unit mass of a pure radioisotope. *See* **radiation units.**

additive process *See* **colour.**

adiabatic approximation An approximation used in *quantum mechanics when the time dependence of parameters, such as the inter-nuclear distance between atoms in a molecule is slowly varying. This approximation means that the solution of the *Schrödinger equation at one time goes continuously over to the solution at a later time. This approximation was formulated by Max Born and the Soviet physicist Vladimir Alexandrovich Fock (1898–1974) in 1928. The *Born–Oppenheimer approximation is an example of the adiabatic approximation.

adiabatic demagnetization A technique for cooling a paramagnetic salt, such as potassium chrome alum, to a temperature near *absolute zero The salt is placed between the poles of an electromagnet and the heat produced during magnetization is removed by liquid helium. The salt is then isolated thermally from the surroundings and the field is switched off; the salt is demagnetized adiabatically and its temperature falls. This is because the demagnetized state, being less ordered, involves more energy than the magnetized state. The extra energy can come only from the internal, or thermal, energy of the substance.

adiabatic process Any process that occurs without heat entering or

leaving a system. In general, an adiabatic change involves a fall or rise in temperature of the system. For example, if a gas expands under adiabatic conditions, its temperature falls (work is done against the retreating walls of the container). The *adiabatic equation* describes the relationship between the pressure (p) of an ideal gas and its volume (V), i.e. $pV^{\Gamma} = K$, where γ is the ratio of the principal specific *heat capacities of the gas and K is a constant.

admittance Symbol Y. The reciprocal of *impedance. It is measured in siemens.

adsorbate A substance that is adsorbed on a surface.

adsorption The formation of a layer of gas, liquid, or solid on the surface of a solid or, less frequently, of a liquid. There are two types depending on the nature of the forces involved. In *chemisorption* a single layer of molecules, atoms, or ions is attached to the adsorbent surface by chemical bonds. In *physisorption* adsorbed molecules are held by the weaker *van der Waals' forces. Adsorption is an important feature of surface reactions, such as corrosion, and heterogeneous catalysis. The property is also utilized in adsorption *chromatography.

advanced gas-cooled reactor (AGR) *See* **nuclear reactor**.

aerial (antenna) The part of a radio or television system from which radio waves are transmitted into the atmosphere or space (*transmitting aerial*) or by which they are received (*receiving aerial*). A *directional* or *directive aerial* is one in which energy is transmitted or received more effectively from some directions than others, whereas an *omnidirectional aerial* transmits and receives equally well in all directions.

aerodynamics The study of the motion of gases (particularly air) and the motion of solid bodies in air. Aerodynamics is particularly concerned with the motion and stability of aircraft. Another application of aerodynamics is to the flight of birds and insects. The branch of aerodynamics concerned with the flow of gases through compressors, ducts, fans, orifices, etc., is called *internal aerodynamics*.

Aerodynamic drag is the force that opposes the motion of a body moving relative to a gas and is a function of the density of the gas, the square of the relative velocity, the surface area of the body, and a quantity called the *drag coefficient*, which is a function of the *Reynolds number. *Aerodynamic lift* is an upward force experienced by a body moving through a gas and is a function of the same variables as aerodynamic drag.

aerogenerator *See* **wind power**.

aeronautics The branch of *aerodynamics concerned with the design, construction, and operation of aircraft and rockets.

aerosol A colloidal dispersion of a solid or liquid in a gas. The commonly used aerosol sprays contain an inert propellant liquefied under pressure. Halogenated alkanes containing chlorine and fluorine (chlorofluorocarbons,

or CFCs) have been used in aerosol cans. This use has been criticized on the grounds that these compounds persist in the atmosphere and lead to depletion of the ozone layer.

aerospace The earth's atmosphere and the space beyond it.

AFM *See* **atomic force microscope.**

after-heat Heat produced by a nuclear reactor after it has been shut down. The after-heat is generated by radioactive substances formed in the fuel elements.

age of the earth The time since the earth emerged as a planet of the sun, estimated by *dating techniques to be about 4.6×10^9 years. The oldest known rocks on earth are estimated by their *radioactive age to be about 3.5×10^9 years old. The earth is older than this because of the long time it took to cool. An estimate for the cooling time is included in the estimate for the age of the earth.

age of the universe A time determined by the reciprocal of the value of the *Hubble constant to be between 10 and 20 billion years. The calculation of the Hubble constant, and hence the age of the universe, depends on which theory of *cosmology is used. Usually, the age of the universe is calculated by assuming that the *expansion of the universe can be described by the *big-bang theory. Some estimates for the age of the universe suggest a figure that is less than the age of some stars in the universe, which would constitute a major paradox for cosmology.

AGR Advanced gas-cooled reactor. *See* **nuclear reactor.**

AI *See* **artificial intelligence.**

air *See* **earth's atmosphere.**

albedo **1.** The ratio of the radiant flux reflected by a surface to that falling on it. **2.** The probability that a neutron entering a body of material will be reflected back through the same surface as it entered.

algebraic sum The total of a set of quantities paying due regard to sign, e.g. the algebraic sum of 3 and −4 is −1.

algorithm A method of solving a problem, involving a finite series of steps. In computing practice the algorithm denotes the expression on paper of the proposed computing process (often by means of a flowchart) prior to the preparation of the program. If no algorithm is possible a *heuristic solution has to be sought.

allowed bands *See* **energy bands.**

allowed transitions *See* **selection rules.**

alloy A material consisting of two or more metals (e.g. brass is an alloy of copper and zinc) or a metal and a nonmetal (e.g. steel is an alloy of iron and

carbon, sometimes with other metals included). Alloys may be compounds, *solid solutions, or mixtures of the components.

alloy steels *See* **steel**.

Alnico A tradename for a series of alloys, containing iron, aluminium, nickel, cobalt, and copper, used to make permanent magnets.

alpha-iron *See* **iron**.

alpha particle A helium-4 nucleus emitted by a larger nucleus during the course of the type of radioactive decay known as *alpha decay*. As a helium-4 nucleus consists of two protons and two neutrons bound together as a stable entity the loss of an alpha particle involves a decrease in *nucleon number of 4 and decrease of 2 in the *atomic number, e.g. the decay of a uranium-238 nucleus into a thorium-234 nucleus. A stream of alpha particles is known as an *alpha-ray* or *alpha-radiation*.

alternating current (a.c.) An electric current that reverses its direction with a constant *frequency (f). If a graph of the current against time has the form of a *sine wave, the current is said to be *sinusoidal*. Alternating current, unlike direct current, is therefore continuously varying and its magnitude is either given as its peak value (I_0) or its *root-mean-square value ($I_0/\sqrt{2}$ for a sinusoidal current). This r.m.s. value is more useful as it is comparable to a d.c. value in being a measure of the ability of the current to transmit power. The instantaneous value of a sinusoidal current (I) is given by $I = I_0 \sin 2\pi ft$.

If a direct current is supplied to a circuit the only opposition it encounters is the circuit's *resistance. However, an alternating current is opposed not only by the resistance of the circuit but also by its *reactance This reactance is caused by *capacitance and *inductance in the circuit. In a circuit consisting of a resistance (R), an inductance (L), and a capacitance (C) all in series, the reactance (X) is equal to $(2\pi fL) - (1/2\pi fC)$. The total opposition to the current, called the *impedance (Z), is then equal to the ratio of the r.m.s. applied p.d. to the r.m.s. current and is given by $\sqrt{(R^2 + X^2)}$.

alternator An *alternating-current generator consisting of a coil or coils that rotate in the magnetic field produced by one or more permanent magnets or electromagnets. The electromagnets are supplied by an independent direct-current source. The frequency of the alternating current produced depends on the speed at which the coil rotates and the number of pairs of magnetic poles. In the large alternators of power stations the electromagnets rotate inside fixed coils; many bicycle dynamos are alternators with rotating permanent magnets inside fixed coils.

altimeter A device used to measure height above sea level. It usually consists of an aneroid *barometer measuring atmospheric pressure. Aircraft are fitted with altimeters, which are set to the atmospheric pressure at a convenient level, usually sea level, before take off. The height of the aircraft can then be read off the instrument as the aircraft climbs and the pressure falls.