K

kainite A naturally occurring double salt of magnesium sulphate and potassium chloride, $MgSO_4.KCl.3H_2O$.

Kainozoic *See* CENOZOIC.

kalinite A mineral form of *aluminium potassium sulphate ($Al_2(SO_4)_3.K_2SO_4.24H_2O$).

kallidin *See* KININ.

Kaluza–Klein theory A type of *unified-field theory that postulates a generalization of the general theory of relativity to higher than four space–time dimensions. In five space–time dimensions this gives general relativity and electromagnetic interactions. In higher space–time dimensions Kaluza–Klein theories give general relativity and more general *gauge theories. A combination of Kaluza–Klein theory and *supersymmetry gives rise to *supergravity, which needs eleven space–time dimensions. In these theories it is proposed that the higher dimensions are 'rolled up' to become microscopically small (a process known as **spontaneous compactification**) with four macroscopic space–time dimensions remaining. It is named after the German mathematician Theodor Kaluza (1885–1954) and the Swedish physicist Oscar Klein (1894–1977).

kame An isolated mound of rock particles, originally formed at the lower end or side of a slow-moving glacier. The mound consists of layers of gravel and sand, which were transported by meltwater and left behind when the ice melted. *See also* ESKER.

kaolin (china clay) A soft white clay that is composed chiefly of the mineral kaolinite (*see* CLAY MINERALS). It is formed during the weathering and hydrothermal alteration of other clays or feldspar. Kaolin is mined in the UK, France, the Czech Republic, and USA. Besides its vital importance in the ceramics industry it is also used extensively as a filler in the manufacture of rubber, paper, paint, and textiles and as a constituent of medicines.

kaon A K-meson. *See* MESON.

karst A type of broken limestone terrain, characterized by fissures (grikes) and depressions (dolines). A typical karst landscape, lacking vegetation, resembles an area paved with large slabs of limestone. Rainwater percolates through the fissures into the rock beneath, where it can follow bedding planes and form underground streams, which carve out caves. Surface streams may disappear down *sink holes.

karyogamy The fusion of nuclei or nuclear material that occurs during sexual reproduction. *See* FERTILIZATION.

karyogram (idiogram) A diagram representing the characteristic features of the *chromosomes of a species.

karyokinesis The division of a cell nucleus. *See* MEIOSIS; MITOSIS.

karyotype The number and structure of the *chromosomes in the nucleus of a cell. The karyotype is identical in all the *diploid cells of an organism.

Kastle Meyer test (phenolphthalein test) A presumptive test used to indicate blood. Phenolphthalein and hydrogen peroxide are used; reaction with haemoglobin in the blood gives a pink colour.

katal Symbol kat. A non-SI unit of enzyme activity defined as the catalytic activity of an enzyme that increases the rate of conversion of a specified chemical reaction by 1 mol s^{-1} under specified assay conditions.

Kater's pendulum A complex *pendulum designed by Henry Kater (1777–1835) to measure the acceleration of free fall. It consists of a metal bar with knife edges attached near the ends and two weights that can slide between the knife edges. The bar is pivoted from each knife edge in turn and the positions of the weights are adjusted so that the period of the pendulum is the same with both pivots. The period is then given by the formula for a simple pendulum, which enables g to be calculated.

katharometer An instrument for comparing the thermal conductivities of two gases

by comparing the rate of loss of heat from two heating coils surrounded by the gases. The instrument can be used to detect the presence of a small amount of an impurity in air and is also used as a detector in gas chromatography.

kb *See* KILOBASE.

KDa *See* KILODALTON.

keel (carina) The projection of bone from the sternum (breastbone) of a bird or bat, to which the powerful flight muscles are attached. The sterna of flightless birds (e.g. ostrich and emu) lack keels.

keeper A piece of soft iron used to bridge the poles of a permanent magnet when it is not in use. It reduces the leakage field and thus preserves the magnetization.

Kekulé, Friedrich August von Stradonitz (1829–96) German chemist, who became professor at Ghent (1858) and later at Bonn (1867). He studied the structures of organic molecules and is best remembered for his structure for *benzene, which he correctly interpreted as having a symmetrical ring of six carbon atoms.

Kekulé structure A proposed structure of *benzene in which the molecule has a hexagonal ring of carbon atoms linked by alternating double and single bonds. Kekulé structures contribute to the resonance hybrid of benzene. The structure was suggested in 1865 by Friedrich August Kekulé.

kelp Any large brown seaweed (*see* PHAEOPHYTA) or its ash, used as a source of iodine.

kelvin Symbol K. The *SI unit of thermodynamic *temperature equal to the fraction 1/273.16 of the thermodynamic temperature of the *triple point of water. The magnitude of the kelvin is equal to that of the degree celsius (centigrade), but a temperature expressed in degrees celsius is numerically equal to the temperature in kelvins less 273.15 (i.e. °C = K – 273.15). The *absolute zero of temperature has a temperature of 0 K (–273.15°C). The former name **degree kelvin** (symbol °K) became obsolete by international agreement in 1967. The unit is named after Lord Kelvin.

Kelvin, Baron (William Thomson; 1824–1907) British physicist, born in Belfast, who became professor of natural philosophy at Glasgow University in 1846. He carried out important experimental work on electromagnetism, inventing the mirror *galvanometer and contributing to the development of telegraphy. He also worked with James *Joule on the *Joule–Thomson (or Joule–Kelvin) effect. His main theoretical work was in *thermodynamics, in which he stressed the importance of the conservation of energy (*see* CONSERVATION LAW). He also introduced the concept of *absolute zero and the Kelvin temperature scale based on it; the unit of thermodynamic temperature is named after him.

Kelvin effect *See* THOMSON EFFECT.

Kepler, Johannes (1571–1630) German astronomer, whose achievements helped vindicate the heliocentric theory of *Copernicus. In 1600 Kepler went to Prague to work for Tycho *Brahe, whom he succeeded as imperial mathematician to the court of the Holy Roman Emperor Rudolf II. During his time in Prague, Kepler used the decades of accurate and systematic observational data collected by Tycho to formulate his three laws of planetary motion (*see* KEPLER'S LAWS) and to publish the *Rudolphine Tables* (1627), a set of mathematical tables providing instructions for finding the positions of the planets together with a comprehensive star catalogue. Kepler also did pioneering work in optics, making an improved refracting telescope (the **Keplerian telescope**).

Kepler's laws Three laws of planetary motion formulated by Johannes Kepler on the basis of observations made by Tycho Brahe. Kepler published the first and second laws in 1609 and the third in 1619. The laws state that: (1) the orbits of the planets are elliptical with the sun at one *focus of the ellipse; (2) each planet revolves around the sun so that an imaginary line (the **radius vector**) connecting the planet to the sun sweeps out equal areas in equal time periods; (3) the ratio of the square of each planet's *sidereal period to the cube of its distance from the sun is a constant for all the planets.

keratin Any of a group of fibrous *proteins occurring in hair, feathers, hooves, and horns. Keratins have coiled polypeptide chains that combine to form supercoils of several polypeptides linked by disulphide bonds between adjacent cysteine amino acids. Aggregates of these supercoils form microfibrils, which are embedded in a protein matrix. This produces a strong but elastic structure.

keratinization (cornification) The process in which the cytoplasm of the outermost cells of the mammalian *epidermis is replaced by *keratin. Keratinization occurs in the *stratum corneum, feathers, hair, claws, nails, hooves, and horns.

kerosine *See* PETROLEUM.

Kerr effect The ability of certain substances to refract differently light waves whose vibrations are in two directions (*see* DOUBLE REFRACTION) when the substance is placed in an electric field. The effect, discovered in 1875 by John Kerr (1824–1907), is caused by the fact that certain molecules have electric *dipoles, which tend to be orientated by the applied field; the normal random motions of the molecules tends to destroy this orientation and the balance is struck by the relative magnitudes of the field strength, the temperature, and the magnitudes of the dipole moments.

The Kerr effect is observed in a **Kerr cell**, which consists of a glass cell containing the liquid or gaseous substance; two capacitor plates are inserted into the cell and light is passed through it at right angles to the electric field. There are two principal indexes of refraction: n_o (the ordinary index) and n_e (the extraordinary index). The difference in the velocity of propagation in the cell causes a phase difference, δ, between the two waves formed from a beam of monochromatic light, wavelength λ, such that

$$\delta = (n_o - n_e)x/\lambda,$$

where x is the length of the light path in the cell. Kerr also showed empirically that the ratio

$$(n_o - n_e)\lambda = BE^2,$$

where E is the field strength and B is a constant, called the **Kerr constant**, which is characteristic of the substance and approximately inversely proportional to the thermodynamic temperature.

The **Kerr shutter** consists of a Kerr cell filled with a liquid, such as nitrobenzene, placed between two crossed polarizers; the electric field is arranged to be perpendicular to the axis of the light beam and at 45° to the axis of the polarizers. In the absence of a field there is no optical path through the device. When the field is switched on the nitrobenzene becomes doubly refracting and a path opens between the crossed polarizers.

ketals Organic compounds, similar to *acetals, formed by addition of an alcohol to a ketone. If one molecule of ketone (RR′CO) reacts with one molecule of alcohol R″OH, then a **hemiketal** is formed. The rings of ketose sugars are hemiketals. Further reaction produces a full ketal ($RR'C(OR'')_2$).

SEE WEB LINKS

- Information about IUPAC nomenclature

ketamine A veterinary anaesthetic that is used illegally as a club drug. It is a class A drug in the UK.

ketene **1.** The compound $CH_2=C=O$ (**ethenone**). **2.** Any of a class of compounds of the type $R_1R_2=C=O$, where R_1 and R_2 are organic groups. Ketenes are reactive compounds and are often generated in a reaction medium for organic synthesis.

SEE WEB LINKS

- Information about IUPAC nomenclature

keto–enol tautomerism A form of tautomerism in which a compound containing a $–CH_2–CO–$ group (the **keto form** of the molecule) is in equilibrium with one containing the $–CH=C(OH)–$ group (the **enol**). It occurs by migration of a hydrogen atom between a carbon atom and the oxygen on an adjacent carbon. *See* ISOMERISM.

keto form *See* KETO–ENOL TAUTOMERISM.

ketohexose *See* MONOSACCHARIDE.

ketone body Any of three compounds, acetoacetic acid (3-oxobutanoic acid, CH_3COCH_2COOH), β-hydroxybutyric acid (3-hydroxybutanoic acid, $CH_3CH(OH)CH_2COOH$), and acetone (propanone, CH_3COCH_3), all of which are produced by the liver as a result of the metabolism of body fat deposits. Ketone bodies are normally used as energy sources by peripheral tissues. However, if carbohydrate supply is limited (e.g. during starvation or in diabetics), the blood level of ketone bodies rises and they may be present in urine, giving it a characteristic ‘pear drops’ odour. This condition is called **ketosis**.

ketones Organic compounds that contain the carbonyl group (>C=O) linked to two hydrocarbon groups. The **ketone group** is a carbonyl group with two single bonds to other carbon atoms. In systematic chemical nomenclature, ketone names end with the suffix *-one*. Examples are propanone (acetone), CH_3COCH_3, and butanone (methyl ethyl ketone), $CH_3COC_2H_5$. Ketones can be made by oxidizing secondary alcohols to

convert the C–OH group to C=O. Certain ketones form addition compounds with sodium hydrogensulphate(IV) (sodium hydrogensulphite). They also form addition compounds with hydrogen cyanide to give *cyanohydrins and with alcohols to give *ketals. They undergo condensation reactions to yield *oximes, *hydrazones, phenylhydrazones, and *semicarbazones. These are reactions that they share with aldehydes. Unlike aldehydes, they do not affect Fehling's solution or Tollen's reagent and do not easily oxidize. Strong oxidizing agents produce a mixture of carboxylic acids; butanone, for example, gives ethanoic and propanoic acids.

SEE WEB LINKS

- Information about IUPAC nomenclature

ketopentose *See* MONOSACCHARIDE.

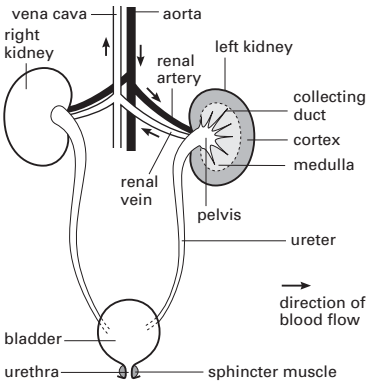
ketose *See* MONOSACCHARIDE.

keystone species A species whose impact on its community is disproportionately large relative to its abundance. This is generally because it alone fulfils some crucial functional role in the community, the continuation of which is essential for the survival of numerous other species. Classic examples are the beaver (*Castor* spp.), whose dam building creates the unique beaver ponds on which many other species depend, and the bison (*Bos bison*), responsible for a mosaic-like grazing pattern that underpinned the biodiversity of the grasslands of North America.

khat A plant, *Catha edilis*, found in East Africa and the Arabian peninsular. The leaves are chewed to give a mildly stimulating and euphoric effect. Its activity comes from two alkaloids: *cathine and, in fresh leaves, the more potent *cathinone. It is a controlled substance in many countries including the US. In the UK it is not a controlled substance and is used by certain Somalian and Yemeni ethnic groups.

kibi- *See* BINARY PREFIXES.

kidney The main organ of *excretion of vertebrates, through which nitrogenous waste material (usually in the form of *urine) is eliminated from the body. In mammals there is a pair of kidneys situated in the abdomen (see illustration). Each has an outer **cortex** and an inner **medulla** and is made up of tubular units called *nephrons, through which nitrogenous waste is filtered from the blood, with the formation of urine. The nephrons drain into a basin-like cavity in the kidney (the **renal pelvis**), which leads to the *ureter and *bladder.



Kidney. The kidneys of a mammal.

kieselguhr A soft fine-grained deposit consisting of the siliceous skeletal remains of diatoms, formed in lakes and ponds. Kieselguhr is used as an absorbent, filtering material, filler, and insulator.

kieserite A mineral form of *magnesium sulphate monohydrate, $MgSO_4.H_2O$.

killer cell *See* NATURAL KILLER CELL; T CELL.

kilo- Symbol k. A prefix used in the metric system to denote 1000 times. For example, 1000 volts = 1 kilovolt (kV).

kilobase Symbol kb. A unit used at the molecular level for measuring distances along nucleic acids, chromosomes, or genes, equal to 1000 bases (equivalent to 1000 nucleotides or base pairs). *See also* BASE PAIR.

kilodalton Symbol kDa. A non-SI unit of mass used to express molecular mass, especially for large molecules, such as proteins and polysaccharides. It is equal to 1000 daltons (*see* ATOMIC MASS UNIT).

kilogram Symbol kg. The *SI unit of mass defined as a mass equal to that of the international platinum–iridium prototype kept by the International Bureau of Weights and Measures at Sèvres, near Paris.

kiloton weapon A nuclear weapon with an explosive power equivalent to one thou-

sand tons of TNT. *Compare* MEGATON WEAPON.

kilowatt-hour Symbol kWh. The commercial unit of electrical energy. It is equivalent to a power consumption of 1000 watts for 1 hour. 1 kWh = 3.6×10^6 joules.

kimberlite A rare igneous rock that often contains diamonds. It occurs as narrow pipe intrusions but is often altered and fragmented. It consists of olivine and phlogopite mica, usually with calcite, serpentine, and other minerals. The chief occurrences of kimberlite are in South Africa, especially at Kimberley (after which the rock is named), and in the Yakutia area of Siberia.

kinase An enzyme that can transfer a phosphate group from a high-energy phosphate, such as ATP, to an organic molecule. *Phosphorylation is normally required to activate the molecule, which is often an enzyme. For example, kinases activate the precursors of enzymes secreted in pancreatic juice (*see* CHYMOTRYPSIN; TRYPSIN).

kinematic equation *See* EQUATION OF MOTION.

kinematics The branch of mechanics concerned with the motions of objects without being concerned with the forces that cause the motion. In this latter respect it differs from *dynamics, which is concerned with the forces that affect motion. *See also* EQUATION OF MOTION.

kinematic viscosity Symbol ν. The ratio of the *viscosity of a liquid to its density. The SI unit is $m^2\ s^{-1}$.

kinesis The movement of a cell or organism in response to a stimulus in which the rate of movement depends on the intensity (rather than the direction) of the stimulus. For example, a woodlouse moves slowly in a damp atmosphere and quickly in a dry one.

kinetic effect A chemical effect that depends on reaction rate rather than on thermodynamics. For example, diamond is thermodynamically less stable than graphite; its apparent stability depends on the vanishingly slow rate at which it is converted. *Overpotential in electrolytic cells is another example of a kinetic effect. **Kinetic isotope effects** are changes in reaction rates produced by isotope substitution. For example, if the slow step in a chemical reaction is the breaking of a C–H bond, the rate for the deuterated compound would be slightly lower because of the lower vibrational frequency of the C–D bond. Such effects are used in investigating the mechanisms of chemical reactions.

kinetic energy *See* ENERGY.

kinetic equations Equations used in *kinetic theory. The *Boltzmann equation is an example of a kinetic equation. An important application of kinetic equations is to calculate *transport coefficients (and inverse transport coefficients), such as *conductivity and *viscosity in *non-equilibrium statistical mechanics. In general, kinetic equations do not have exact solutions for interacting systems. If the system is near to *equilibrium an approximation technique can be used by regarding the deviation from equilibrium as a *perturbation.

kinetic isotope effect *See* KINETIC EFFECT.

kinetics The branch of physical chemistry concerned with measuring and studying the rates of chemical reactions. The main aim of chemical kinetics is to determine the mechanism of reactions by studying the rate under different conditions (temperature, pressure, etc.).

kinetic theory A theory, largely the work of Count Rumford, James Joule, and James Clerk Maxwell, that explains the physical properties of matter in terms of the motions of its constituent particles. In a gas, for example, the pressure is due to the incessant impacts of the gas molecules on the walls of the container. If it is assumed that the molecules occupy negligible space, exert negligible forces on each other except during collisions, are perfectly elastic, and make only brief collisions with each other, it can be shown that the pressure p exerted by one mole of gas containing n molecules each of mass m in a container of volume V, will be given by:

$$p = nm(\bar{c})^2/3V,$$

where $\bar{c}^2$ is the mean square speed of the molecules. As according to the *gas laws for one mole of gas: $pV = RT$, where T is the thermodynamic temperature, and R is the molar *gas constant, it follows that:

$$RT = nm(\bar{c})^2/3$$

Thus, the thermodynamic temperature of a gas is proportional to the mean square speed of its molecules. As the average kinetic *en-

ergy of translation of the molecules is $m(\bar{c})^2/2$, the temperature is given by:

$$T = (m(\bar{c})^2/2)(2n/3R)$$

The number of molecules in one mole of any gas is the *Avogadro constant, N_A; therefore in this equation $n = N_A$. The ratio R/N_A is a constant called the *Boltzmann constant (k). The average kinetic energy of translation of the molecules of one mole of any gas is therefore $3kT/2$. For monatomic gases this is proportional to the *internal energy (U) of the gas, i.e.

$$U = N_A 3kT/2$$

and as $k = R/N_A$

$$U = 3RT/2$$

For diatomic and polyatomic gases the rotational and vibrational energies also have to be taken into account (*see* DEGREES OF FREEDOM).

In liquids, according to the kinetic theory, the atoms and molecules still move around at random, the temperature being proportional to their average kinetic energy. However, they are sufficiently close to each other for the attractive forces between molecules to be important. A molecule that approaches the surface will experience a resultant force tending to keep it within the liquid. It is, therefore, only some of the fastest moving molecules that escape; as a result the average kinetic energy of those that fail to escape is reduced. In this way evaporation from the surface of a liquid causes its temperature to fall.

In a crystalline solid the atoms, ions, and molecules are able only to vibrate about the fixed positions of a *crystal lattice; the attractive forces are so strong at this range that no free movement is possible.

kinetochore A platelike structure by which the microtubules of the *spindle attach to the *centromere of a chromosome during nuclear division. It acts as a motor, pulling the centromere along the attached microtubules towards the spindle pole.

kinetosome (basal body) *See* UNDULIPODIUM.

kingdom In traditional classification systems, the highest category into which organisms are classified. The original two kingdoms, Plantae (*see* PLANT) and Animalia (*see* ANIMAL), were over time increased to five: Bacteria (or Prokaryotae; *see* BACTERIA), Protoctista (including protozoa and algae), Fungi (*see* FUNGI), Plantae, and Animalia. However, the discovery of the archaebacteria (*see* ARCHAEA) led taxonomists to suggest a superordinate category in the taxonomic hierarchy – the *domain. According to modern molecular systematics, there are three domains, but the number of kingdoms is much harder to determine.

kinin **1.** One of a group of peptides, occurring in blood, that are involved in inflammation. Kinins are formed in response to blood-vessel injury by the enzymatic splitting of blood plasma globulins (**kininogens**) at the site of inflammation. Kinins include **bradykinin** and **kallidin**. They cause local increases in the permeability of small blood vessels. **2.** *See* CYTOKININ.

kinomere *See* CENTROMERE.

kin selection Natural selection of genes that tend to cause the individuals bearing them to be altruistic to close relatives. These relatives therefore have a higher probability of bearing identical copies of those same genes than do other members of the population. Thus kin selection for a gene that tends to cause an animal to share food with a close relative will result in the gene being spread through the population because it (unconsciously) benefits itself. The more closely two animals are related, the higher the probability that they share some identical genes and therefore the more closely their interests coincide. Parental care is a special case of kin selection. *See* INCLUSIVE FITNESS.

Kipp's apparatus A laboratory apparatus for making a gas by the reaction of a solid with a liquid (e.g. the reaction of hydrochloric acid with iron sulphide to give hydrogen sulphide). It consists of three interconnected glass globes arranged vertically, with the solid in the middle globe. The upper and lower globes are connected by a tube and contain the liquid. The middle globe has a tube with a tap for drawing off gas. When the tap is closed, pressure of gas forces the liquid down in the bottom reservoir and up into the top, and reaction does not occur. When the tap is opened, the release in pressure allows the liquid to rise into the middle globe, where it reacts with the solid. It is named after Petrus Kipp (1808–64).

Kirchhoff, Gustav Robert (1824–87) German physicist, who in 1850 became a professor at Breslau and four years later joined Robert *Bunsen at Heidelberg. In 1845, while still a student, he formulated

*Kirchhoff's laws concerning electric circuits. With Bunsen he worked on spectroscopy, a technique that led them to discover the elements *caesium (1860) and *rubidium (1861).

Kirchhoff's law of radiation A law stating that the emissivity of a body is equal to its absorptance at the same temperature.

Kirchhoff's laws Two laws relating to electric circuits, first formulated by Gustav Kirchhoff. (a) The current law states that the algebraic sum of the currents flowing through all the wires in a network that meet at a point is zero. (b) The voltage law states that the algebraic sum of the e.m.f.s within any closed circuit is equal to the sum of the products of the currents and the resistances in the various portions of the circuit.

Kirkwood gap Any of several spaces in the distribution of *asteroids in the main belt that correspond to locations of *orbital resonance with Jupiter. Consequently any asteroids found there have long ago been perturbed by Jupiter's enormous gravitational influence into more eccentric orbits. The gaps were discovered by the American astronomer Daniel Kirkwood (1814–95).

Kjeldahl's method A method for measuring the percentage of nitrogen in an organic compound. The compound is boiled with concentrated sulphuric acid and copper(II) sulphate catalyst to convert any nitrogen to ammonium sulphate. Alkali is added and the mixture heated to distil off ammonia. This is passed into a standard acid solution, and the amount of ammonia can then be found by estimating the amount of unreacted acid by titration. The amount of nitrogen in the original specimen can then be calculated. The method was developed by the Danish chemist Johan Kjeldahl (1849–1900).

klinostat A device used in experiments to test the influence of gravity on the growth movements of plants (*see* GEOTROPISM). It consists of a motor that slowly rotates a drum inside which seedlings are attached. This prevents any single part of the seedlings from receiving uninterrupted gravitational stimulation and results in horizontal growth of the seedlings.

klystron An electron tube that generates or amplifies microwaves by **velocity modulation**. Several types are used; in the simple two-cavity klystron a beam of high-energy electrons from an electron gun is passed through a *resonant cavity, where it interacts with high-frequency radio waves. This microwave energy modulates the velocities of the electrons in the beam, which then enters a drift space where the faster electrons overtake the slower ones to form bunches. The bunched beam now has an alternating component, which is transferred to an output cavity and thence to an output waveguide.

knee-jerk reflex *See* STRETCH REFLEX.

knockin A technique related to gene *knockout in which a gene is inserted into the genome of a cell, cell line, or organism. Such an insertion can be targeted to a particular site in the genome and may replace or supplement existing genes. Moreover, it can be induced to switch on only in certain tissues, or at certain stages of development, thus mimicking the normal behaviour of genes.

knocking The metallic sound produced by a spark-ignition petrol engine under certain conditions. It is caused by rapid combustion of the unburnt explosive mixture in the combustion chambers ahead of the flame front. As the flame travels from the sparking plug towards the piston it compresses and heats the unburnt gases ahead of it. If the flame front moves fast enough, normal combustion occurs and the explosive mixture is ignited progressively by the flame. If it moves too slowly, ignition of the last part of the unburnt gas can occur very rapidly before the flame reaches it, producing a shock wave that travels back and forth across the combustion chamber. The result is overheating, possible damage to the plugs, an undesirable noise, and loss of power (probably due to preignition caused by overheated plugs). Knocking can be avoided by an engine design that increases turbulence in the combustion chamber and thereby increases flame speed. It also can be avoided by reducing the compression ratio, but this involves loss of efficiency. The most effective method is to use high-octane fuel (*see* OCTANE NUMBER), which has a longer self-ignition delay than low-octane fuels. This can be achieved by the addition of an **antiknock agent**, such as lead(IV) tetraethyl, to the fuel, which retards the combustion chain reactions. However, lead-free petrol is now preferred to petrol containing lead tetraethyl owing to environmental dangers arising from lead in the atmosphere. In the USA the addition of lead compounds is now forbidden. New for-

mulae for petrol are designed to raise the octane number without polluting the atmosphere. These new formulae include increasing the content of aromatics and oxygenates (oxygen-containing compounds, such as alcohols). However, it is claimed that the presence in the atmosphere of incompletely burnt aromatics constitutes a cancer risk.

knockout Inactivation of a particular gene or genes within an organism or cell in order to assess the impact of this defect on the organism. One technique involves genetically engineering laboratory animals (especially mice) so that a normal gene is replaced with a defective homologous gene. Experiments with mice treated in this way reveal how defects in particular genes can affect the development and life of the animal. A less laborious technique uses the phenomenon of *RNA interference to suppress the expression of specific genes in cultured tissue cells – so-called **gene silencing**.

knotane *See* MOLECULAR KNOT.

Knudsen flow *See* MOLECULAR FLOW.

Koch, Robert *See* EHRLICH, PAUL.

Kohlrausch's law If a salt is dissolved in water, the conductivity of the (dilute) solution is the sum of two values – one depending on the positive ions and the other on the negative ions. The law, which depends on the independent migration of ions, was deduced experimentally by the German chemist Friedrich Kohlrausch (1840–1910).

Kolbe's method A method of making alkanes by electrolysing a solution of a carboxylic acid salt. For a salt Na^+RCOO^-, the carboxylate ions lose electrons at the cathode to give radicals:

$$RCOO^- - e \rightarrow RCOO\cdot$$

These decompose to give alkyl radicals

$$RCOO\cdot \rightarrow R\cdot + CO_2$$

Two alkyl radicals couple to give an alkane

$$R\cdot + R\cdot \rightarrow RR$$

The method can only be used for hydrocarbons with an even number of carbon atoms, although mixtures of two salts can be electrolysed to give a mixture of three products. The method was discovered by the German chemist Herman Kolbe (1818–84), who electrolysed pentanoic acid (C_4H_9COOH) in 1849 and obtained a hydrocarbon, which he assumed was the substance 'butyl' C_4H_9 (actually octane, C_8H_{18}).

Kovar A trade name for an alloy of iron, cobalt, and nickel with an *expansivity similar to that of glass. It is therefore used in making glass-to-metal seals, especially in circumstances in which a temperature variation can be expected.

Krebs, Sir Hans Adolf (1900–81) German-born British biochemist, who emigrated to Britain in 1933, working at Sheffield University before moving to Oxford in 1954. Krebs is best known for the *Krebs cycle, the basis of which he discovered in 1937. Details were later added by Fritz Lipmann (1899–1986), with whom Krebs shared the 1953 Nobel Prize for physiology or medicine.

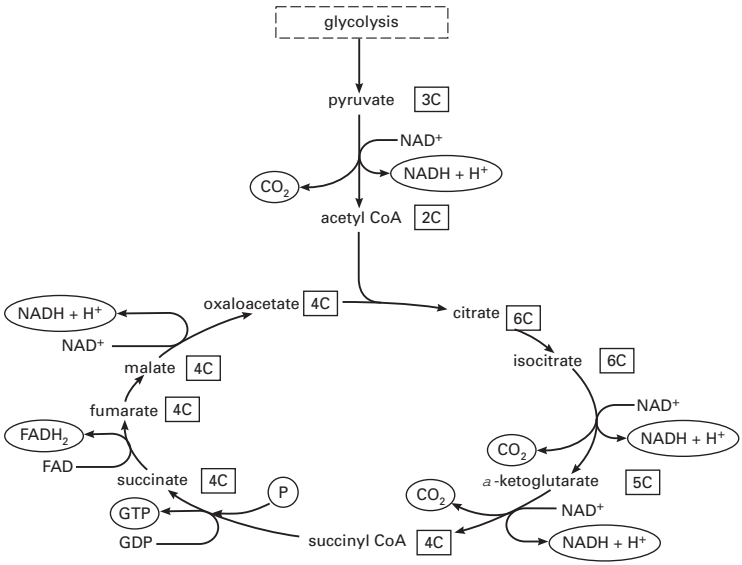
Krebs cycle (citric acid cycle; tricarboxylic acid cycle; TCA cycle) A cyclical series of biochemical reactions that is fundamental to the metabolism of aerobic organisms, i.e. animals, plants, and many microorganisms (see illustration overleaf). The enzymes of the Krebs cycle are located in the *mitochondria and are in close association with the components of the *electron transport chain. The two-carbon *acetyl coenzyme A (acetyl CoA) reacts with the four-carbon oxaloacetate to form the six-carbon citrate. In a series of seven reactions, this is reconverted to oxaloacetate and produces two molecules of carbon dioxide. Most importantly, the cycle generates one molecule of guanosine triphosphate (GTP – equivalent to 1 ATP) and reduces three molecules of the coenzyme *NAD to NADH and one molecule of the coenzyme *FAD to $FADH_2$. NADH and $FADH_2$ are then oxidized by the electron transport chain to generate three and two molecules of ATP respectively. This gives a net yield of 12 molecules of ATP per molecule of acetyl CoA.

Acetyl CoA can be derived from carbohydrates (via *glycolysis), fats, or certain amino acids. (Other amino acids may enter the cycle at different stages.) Thus the Krebs cycle is the central 'crossroads' in the complex system of metabolic pathways and is involved not only in degradation and energy production but also in the synthesis of biomolecules. It is named after its principal discoverer, Sir Hans Krebs.

Kroll process A process for producing certain metals by reducing the chloride with magnesium metal, e.g.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

krypton Symbol Kr. A colourless gaseous



Krebs cycle.

element belonging to group 0 (the *noble gases) of the periodic table; a.n. 36; r.a.m. 83.80; d. 3.73 g m^{-3}; m.p. –156.6°C; b.p. –152.3°C. Krypton occurs in the air (0.0001% by volume) from which it can be extracted by fractional distillation of liquid air. Usually, the element is not isolated but is used with other inert gases in fluorescent lamps, etc. The element has five natural isotopes (mass numbers 78, 80, 82, 83, 84) and there are five radioactive isotopes (76, 77, 79, 81, 85). Krypton–85 (half-life 10.76 years) is produced in fission reactors and it has been suggested that an equilibrium amount will eventually occur in the atmosphere. The element is practically inert and forms very few compounds (certain fluorides, such as KrF_2, have been reported).

SEE WEB LINKS

- Information from the WebElements site

***K* selection** A type of selection that favours organisms with a low rate of reproduction but whose populations expand to the maximum number of individuals that the habitat can support (the *carrying capacity of the habitat). *K*-selected species (or ***K* strategists**) tend to be highly adapted to their environment and are able to compete successfully for food and other resources. They also tend to inhabit stable environments and have relatively long life spans. *Compare* R SELECTION.

K–T boundary *See* ALVAREZ EVENT.

Kuiper belt A large wide ring of small celestial bodies thought to be composed mostly of ice that orbit the sun beyond the planet Neptune. Short-period *comets are thought to originate either in this region or from further out in the *scattered disc. Kuiper belt objects (KBOs) orbit close to the plane of the solar system in a region that extends from Neptune's orbital path 30 astronomical units (AU) out from the sun to a distance of about 55 AU. Some astronomers believe that there could be as many as 70 000 KBOs in excess of 100 km across. *See* SOLAR SYSTEM (Feature).

SEE WEB LINKS

- The Kuiper Belt Home Page, maintained by David Jewett, one of the co-discoverers of the first known Kuiper belt object in 1992

Kundt's tube An apparatus designed by August Kundt (1839–94) in 1866 to measure

the speed of sound in various fluids. It consists of a closed glass tube into which a dry powder (such as lycopodium) has been sprinkled. The source of sound in the original device was a metal rod clamped at its centre with a piston at one end, which is inserted into the tube. When the rod is stroked, sound waves generated by the piston enter the tube. If the position of the piston in the tube is adjusted so that the gas column is a whole number of half wavelengths long, the dust will be disturbed by the resulting *stationary waves forming a series of striations, enabling distances between *nodes to be measured. The vibrating rod can be replaced by a small loudspeaker fed by an oscillator.

Kupfer nickel A naturally occurring form of nickel arsenide, NiAs; an important ore of nickel.

kurchatovium *See* TRANSACTINIDE ELEMENTS.

kwashiorkor *See* MALNUTRITION.

Kyoto Protocol *See* GLOBAL WARMING.