

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.

adipic acid *See* hexanedioic acid.

ADP *See* ATP.

adrenaline (epinephrine) A hormone, produced by the medulla of the adrenal glands, that increases heart activity, improves the power and prolongs the action of muscles, and increases the rate and depth of breathing to prepare the body for 'fright, flight, or fight'. At the same time it inhibits digestion and excretion.

adsorbate A substance that is adsorbed on a surface.

adsorption The formation of a layer of gas 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.

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, such as dichlorodifluoromethane, are commonly used in aerosol cans. This use has been criticized on the grounds that these compounds

persist in the atmosphere and may eventually (it is claimed) affect the *ozone layer.

agar An extract of certain species of red seaweeds that is used as a gelling agent in microbiological culture media, foodstuffs, medicines, and cosmetic creams and jellies. *Nutrient agar* consists of a broth made from beef extract or blood that is gelled with agar and used for the cultivation of bacteria, fungi, and some algae.

agate A variety of *chalcedony that forms in rock cavities and has a pattern of concentrically arranged bands or layers that lie parallel to the cavity walls. These layers are frequently alternating tones of brownish-red. *Moss agate* does not show the same banding and is a milky chalcedony containing moss-like or dendritic patterns formed by inclusions of manganese and iron oxides. Agates are used in jewellery and for ornamental purposes.

air *See* earth's atmosphere.

alabaster *See* gypsum.

alanine *See* amino acid.

albumin (albumen) One of a group of globular proteins that are soluble in water but form insoluble coagulates when heated. Albumins occur in egg white, blood, milk, and plants. Serum albumins, which constitute about 55% of blood plasma protein, help regulate the osmotic pressure and hence plasma volume. They also bind and transport fatty acids. α -lactalbumin is one of the proteins in milk.

alcohols Organic compounds that contain the -OH group. In systematic chemical nomenclature alcohol names end in the suffix *-ol*. Examples are methanol, CH_3OH , and ethanol, $\text{C}_2\text{H}_5\text{OH}$. *Primary alcohols* have two hydrogen atoms on the carbon joined to the -OH group (i.e. they contain the

AMINO ACID

monium chloride, which is an ionic compound $[(\text{CH}_3)_2\text{NH}_2]^+\text{Cl}^-$. When the amine has a common nonsystematic name the suffix *-ium* can be used; for example, phenylamine (aniline) would give $[\text{C}_6\text{H}_5\text{NH}_2]^+\text{Cl}^-$, known as anilinium chloride. Formerly, such compounds were sometimes called *hydrochlorides*, e.g. aniline hydrochloride with the formula $\text{C}_6\text{H}_5\text{NH}_2\cdot\text{HCl}$.

Salts formed by amines are crystalline substances that are readily soluble in water. Many insoluble **alkaloids* (e.g. quinine and atropine) are used medicinally in the form of soluble salts ('hydrochlorides'). If alkali (sodium hydroxide) is added to solutions of such salts the free amine is liberated.

If all four hydrogen atoms of an ammonium salt are replaced by organic groups a *quaternary ammonium compound* is formed. Such compounds are made by reacting tertiary amines with halogen compounds; for example, trimethylamine $((\text{CH}_3)_3\text{N})$ with chloromethane (CH_3Cl) gives tetramethylammonium chloride, $(\text{CH}_3)_4\text{N}^+\text{Cl}^-$. Salts of this type do not liberate the free amine when alkali is added, and quaternary hydroxides (such as $(\text{CH}_3)_4\text{N}^+\text{OH}^-$) can be isolated. Such compounds are strong alkalis, comparable to sodium hydroxide.

amino acid Any of a group of water-soluble organic compounds that possess both a carboxyl ($-\text{COOH}$) and an amino ($-\text{NH}_2$) group attached to the α -carbon atom. Amino acids can be represented by the general formula $\text{R}-\text{CH}(\text{NH}_2)\text{COOH}$. R may be hydrogen or an organic group and determines the properties of any particular amino acid. Through the formation of peptide bonds, amino acids join together to form short chains (**peptides*) or much longer chains (**polypeptides*). Proteins are composed of various proportions of about 20 commonly occurring amino acids (see table). The sequence of these amino acids in the protein polypeptides determines the shape, properties, and hence biological role of the

protein. Some amino acids that never occur in proteins are nevertheless important, e.g. ornithine and citrulline, which are intermediates in the urea cycle.

Plants and many microorganisms can synthesize amino acids from simple inorganic compounds, but animals rely on adequate supplies in their diet. The **essential* amino acids must be present in the diet whereas others can be manufactured from them.

aminobenzene See phenylamine.

amino group See amines.

ammine A coordination **complex* in which the ligands are ammonia molecules. An example of an ammine is the tetraamminecopper(II) ion $[\text{Cu}(\text{NH}_3)_4]^{2+}$.

ammonia A colourless gas, NH_3 , with a strong pungent odour; r.d. 0.59 (relative to air); m.p. -74°C ; b.p. -30.9°C . It is very soluble in water and soluble in alcohol. The compound may be prepared in the laboratory by the reaction of ammonium salts with bases such as calcium hydroxide, or by the hydrolysis of a nitride. Industrially it is made by the **Haber* process and over 80 million tonnes per year are used either directly or in combination. Major uses are the manufacture of nitric acid, ammonium nitrate, ammonium phosphate, and urea (the last three as fertilizers), explosives, dyestuffs and resins.

Liquid ammonia has some similarity to water as it is hydrogen bonded and has a moderate dielectric constant, which permits it to act as an ionizing solvent. It is weakly self-ionized to give ammonium ions, NH_4^+ and amide ions, NH_2^- . It also dissolves electropositive metals to give blue solutions, which are believed to contain solvated electrons. Ammonia is extremely soluble in water giving basic solutions that contain solvated NH_3 molecules and small amounts of the ions NH_4^+ and OH^- . The combustion of ammonia in air yields nitrogen and

apatite A complex mineral form of *calcium phosphate, $\text{Ca}_5(\text{PO}_4)_3(\text{OH}, \text{F}, \text{Cl})$; the commonest of the phosphate minerals. It has a hexagonal structure and occurs widely as an accessory mineral in igneous rocks (e.g. pegmatite) and often in regional and contact metamorphic rocks, especially limestone. Large deposits occur in the Kola Peninsula, USSR. It is used in the production of fertilizers and is a major source of phosphorus. The enamel of teeth is composed chiefly of apatite.

aqua regia A mixture of concentrated nitric acid and concentrated hydrochloric acid in the ratio 1:3 respectively. It is a very powerful oxidizing mixture and will dissolve all metals (except silver, which forms an insoluble chloride) including such noble metals as gold and platinum, hence its name ('royal water'). Nitrosyl chloride (NOCl) is believed to be one of the active constituents.

aqueous Describing a solution in water.

aragonite A rock-forming anhydrous mineral form of calcium carbonate, CaCO_3 . It is much less stable than *calcite, the commoner form of calcium carbonate, from which it may be distinguished by its greater hardness and specific gravity. Over time aragonite undergoes recrystallization to calcite. Aragonite occurs in cavities in limestone, as a deposit in limestone caverns, as a precipitate around hot springs and geysers, and in high-pressure low-temperature metamorphic rocks; it is also found in the shells of a number of molluscs and corals and is the main constituent of pearls. It is white or colourless when pure but the presence of impurities may tint it grey, blue, green, or pink.

arenes Aromatic hydrocarbons, such as benzene, toluene, and naphthalene.

argentic compounds Compounds of silver in its higher (+2) oxidation state; e.g. argentic oxide is silver(II) oxide (AgO).

argentite A sulphide ore of silver, Ag_2S . It crystallizes in the cubic system but most commonly occurs in massive form. It is dull grey-black in colour but bright when first cut and occurs in veins associated with other silver minerals. Important deposits occur in Mexico, Peru, Chile, Bolivia, Norway, and Czechoslovakia.

argentous compounds Compounds of silver in its lower (+1) oxidation state; e.g. argentous chloride is silver(I) chloride.

arginine See amino acid.

argon Symbol Ar. A monatomic noble gas present in air (0.93%); a.n. 18; r.a.m. 39.948; d. $0.00178 \text{ g cm}^{-3}$; m.p. -189°C ; b.p. -185°C . Argon is separated from liquid air by fractional distillation. It is slightly soluble in water, colourless, and has no smell. Its uses include inert atmospheres in welding and special-metal manufacture (Ti and Zr), and (when mixed with 20% nitrogen) in gas-filled electric-light bulbs. The element is inert and has no true compounds. Lord Rayleigh and Sir William Ramsey identified argon in 1894.

aromatic compound An organic compound that contains a benzene ring in its molecules or that has chemical properties similar to benzene. Aromatic compounds are unsaturated compounds, yet they do not easily partake in addition reactions. Instead they undergo electrophilic substitution.

Benzene, the archetypal aromatic compound, has an hexagonal ring of carbon atoms and the classical formula (the Kekulé structure) would have alternating double and single bonds. In fact all the bonds in benzene are the same length intermediate between double and single C—C bonds. The properties arise because the electrons in the

BALMER SERIES

cally controlled compensation of an electric force. A scanner monitors the displacement of the pan support generating a current proportional to the displacement. This current flows through a coil forcing the pan support to return to its original position by means of a magnetic force. The signal generated enables the mass to be read from a digital display. The mass of the empty container can be stored in the balance's computer memory and automatically deducted from the mass of the container plus its contents.

Balmer series See hydrogen spectrum.

banana bond Informal name for the type of electron-deficient bond holding the B-H-B bridges in *boranes and similar compounds.

band spectrum See spectrum.

band theory See energy bands.

bar A c.g.s. unit of pressure equal to 10^6 dynes per square centimetre or 10^5 pascals (approximately 750 mmHg or 0.987 atmosphere). The *millibar* (100 Pa) is commonly used in meteorology.

Barfoed's test A biochemical test to detect monosaccharide (reducing) sugars in solution, devised by the Swedish physician C. T. Barfoed (1815-99). *Barfoed's reagent*, a mixture of ethanoic (acetic) acid and copper(II) acetate, is added to the test solution and boiled. If any reducing sugars are present a red precipitate of copper(II) oxide is formed. The reaction will be negative in the presence of disaccharide sugars as they are weaker reducing agents.

barite See barytes.

barium Symbol Ba. A silvery-white reactive element belonging to *group II of the periodic table; a.n. 54; r.a.m. 137.33; r.d. 3.51; m.p. 725°C; b.p. 1640°C. It occurs as the

minerals barytes (BaSO_4) and witherite. Extraction is by high-temperature reduction of barium oxide with aluminium or silicon in a vacuum, or by electrolysis of fused barium chloride. The metal is used as a getter in vacuum systems. It oxidizes readily in air and reacts with ethanol and water. Soluble barium compounds are extremely poisonous. It was first identified in 1774 by Karl Scheele, and was extracted by Humphry Davy in 1808.

barium bicarbonate See barium hydrogen-carbonate.

barium carbonate A white insoluble compound, BaCO_3 ; r.d. 4.43. It decomposes on heating to give barium oxide and carbon dioxide:



The compound occurs naturally as the mineral *witherite* and can be prepared by adding an alkaline solution of a carbonate to a solution of a barium salt. It is used as a raw material for making other barium salts, as a flux for ceramics, and as a raw material in the manufacture of certain types of optical glass.

barium chloride A white compound, BaCl_2 . The anhydrous compound has two crystalline forms: an α form (monoclinic; r.d. 3.856), which transforms at 962°C to a β form (cubic; r.d. 3.917; m.p. 963°C; b.p. 1560°C). There is also a dihydrate, $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ (cubic; r.d. 3.1), which loses water at 113°C. It is prepared by dissolving barium carbonate (witherite) in hydrochloric acid and crystallizing out the dihydrate. The compound is used in the extraction of barium by electrolysis.

barium hydrogencarbonate (barium bicarbonate) A compound, $\text{Ba}(\text{HCO}_3)_2$, which is only stable in solution. It can be formed by the action of carbon dioxide on a suspension of barium carbonate in cold water: