



Z boson An electrically neutral elementary particle, Z^0 , which – like W bosons – is thought to mediate the weak interactions in the * electroweak theory. The Z^0 boson was discovered at CERN in 1983 and has a mass of about 90 GeV as had been predicted from theory.

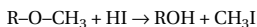
Zeeman effect The splitting of the lines in a spectrum when the source of the spectrum is exposed to a magnetic field. It was discovered in 1896 by Pieter Zeeman (1865–1943). In the **normal Zeeman effect** a single line is split into three if the field is perpendicular to the light path or two lines if the field is parallel to the light path. This effect can be explained by classical electromagnetic principles in terms of the speeding up and slowing down of orbital electrons in the source as a result of the applied field. The **anomalous Zeeman effect** is a complicated splitting of the lines into several closely spaced lines, so called because it does not agree with classical predictions. This effect is explained by quantum mechanics in terms of electron spin.

 **SEE WEB LINKS**

- Pieter Zeeman's paper in *Nature* (1897)

Zeilinger's principle The principle that any elementary system carries just one bit of information. This principle was put forward by the Austrian physicist Anton Zeilinger in 1999 and subsequently developed by him to derive several aspects of quantum mechanics.

Zeisel reaction A method of determining the number of methoxy ($-\text{OCH}_3$) groups in an organic compound. The compound is heated with excess hydroiodic acid, forming an alcohol and iodomethane



The iodomethane is distilled off and led into an alcoholic solution of silver nitrate, where it precipitates silver iodide. This is filtered and weighed, and the number of iodine atoms and hence methoxy groups can be calculated. The method was developed by S. Zeisel in 1886.

Zeise's salt A complex of platinum and ethene, $\text{PtCl}_3(\text{CH}_2\text{CH}_2)$, in which the Pt coordinates to the pi bond of the ethene. It was the first example of an enyl complex, synthesized by W. C. Zeise in 1827.

Zener diode A type of semiconductor diode, consisting of a p - n junction with high doping concentrations on either side of the junction. It acts as a rectifier until the applied reverse voltage reaches a certain value, the **Zener breakdown voltage**, when the device becomes conducting. This effect occurs as a result of electrons being excited directly from the valence band into the conduction band (see ENERGY BANDS). Zener diodes are used in voltage-limiting circuits; they are named after C. M. Zener (1905–93).

zenith The point on the * celestial sphere that lies directly above an observer. *Compare* NADIR.

zeolite A natural or synthetic hydrated aluminosilicate with an open three-dimensional crystal structure, in which water molecules are held in cavities in the lattice. The water can be driven off by heating and the zeolite can then absorb other molecules of suitable size. Zeolites are used for separating mixtures by selective absorption – for this reason they are often called **molecular sieves**. They are also used in sorption pumps for vacuum systems and certain types (e.g. **Permutit**) are used in ion-exchange (e.g. water-softening).

zepto- Symbol z. A prefix used in the metric system to indicate 10^{-21} . For example, 10^{-21} second = 1 zeptosecond (zs).

zero order See ORDER.

zero-point energy The energy remaining in a substance at the * absolute zero of temperature (0 K). This is in accordance with quantum theory, in which a particle oscillating with simple harmonic motion does not have a stationary state of zero kinetic energy. Moreover, the * uncertainty principle does not allow such a particle to be at rest at exactly the centrepoint of its oscillations.

zeroth law of thermodynamics *See* THERMODYNAMICS.

zetta- Symbol Z. A prefix used in the metric system to indicate 10^{21} . For example, 10^{21} metres = 1 zettametre (Zm).

Ziegler process An industrial process for manufacturing high-density polyethene using catalysts of titanium(IV) chloride (TiCl_4) and aluminium alkyls (e.g. triethylaluminium, $\text{Al}(\text{C}_2\text{H}_5)_3$). The process was introduced in 1953 by the German chemist Karl Ziegler (1898–1973). It allowed the manufacture of polythene at lower temperatures (about 60°C) and pressures (about 1 atm.) than used in the original process. Moreover, the polyethene produced had more straight-chain molecules, giving the product more rigidity and a higher melting point than the earlier low-density polyethene. The reaction involves the formation of a titanium alkyl in which the titanium can coordinate directly to the pi bond in ethene.

In 1954 the process was developed further by the Italian chemist Giulio Natta (1903–79), who extended the use of Ziegler's catalysts (and similar catalysts) to other alkenes. In particular he showed how to produce stereospecific polymers of propene.

zinc Symbol Zn. A blue-white metallic element; a.n. 30; r.a.m. 65.38; r.d. 7.1; m.p. 419.88°C ; b.p. 907°C . It occurs in sphalerite (or zinc blende, ZnS), which is found associated with the lead sulphide, and in smithsonite (ZnCO_3). Ores are roasted to give the oxide and this is reduced with carbon (coke) at high temperature, the zinc vapour being condensed. Alternatively, the oxide is dissolved in sulphuric acid and the zinc obtained by electrolysis. There are five stable isotopes (mass numbers 64, 66, 67, 68, and 70) and six radioactive isotopes are known. The metal is used in galvanizing and in a number of alloys (brass, bronze, etc.). Chemically it is a reactive metal, combining with oxygen and other nonmetals and reacting with dilute acids to release hydrogen. It also dissolves in alkalis to give *zincates. Most of its compounds contain the Zn^{2+} ion.



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- Information from the WebElements site

zincate A salt formed in solution by dissolving zinc or zinc oxide in alkali. The formula is often written ZnO_2^{2-} although in aqueous solution the ions present are probably complex ions in which the Zn^{2+} is coordi-

nated to OH^- ions. ZnO_2^{2-} ions may exist in molten sodium zincate, but most solid 'zincates' are mixed oxides.

zinc blende A mineral form of *zinc sulphide, ZnS, the principal ore of zinc (*see* SPHALERITE). The **zinc-blende structure** is the crystal structure of this compound (and of other compounds). It has zinc atoms surrounded by four sulphur atoms at the corners of a tetrahedron. Each sulphur is similarly surrounded by four zinc atoms. The crystals belong to the cubic system.

zinc-blende structure *See* SPHALERITE STRUCTURE.

zinc chloride A white crystalline compound, ZnCl_2 . The anhydrous salt, which is deliquescent, can be made by the action of hydrogen chloride gas on hot zinc; r.d. 2.9; m.p. 283°C ; b.p. 732°C . It has a relatively low melting point and sublimes easily, indicating that it is a molecular compound rather than ionic. Various hydrates also exist. Zinc chloride is used as a catalyst, dehydrating agent, and flux for hard solder. It was once known as **butter of zinc**.

zinc chloride cell *See* DRY CELL.

zinc group The group of elements in the periodic table forming group 12 and consisting of zinc (Zn), cadmium (Cd), and mercury (Hg). They were formerly classified in group IIB of the table (*see* GROUP 2 ELEMENTS).

zincite A mineral form of *zinc oxide, ZnO.

zinc oxide A powder, white when cold and yellow when hot, ZnO; r.d. 5.606; m.p. 1975°C . It occurs naturally as a reddish orange ore **zincite**, and can also be made by oxidizing hot zinc in air. It is amphoteric, forming *zincates with bases. It is used as a pigment (**Chinese white**) and a mild antiseptic in zinc ointments. An archaic name is **philosopher's wool**.

zinc sulphate A white crystalline water-soluble compound made by heating zinc sulphide ore in air and dissolving out and recrystallizing the sulphate. The common form is the heptahydrate, $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$; r.d. 1.9. This loses water above 30°C to give the hexahydrate and more water is lost above 70°C to form the monohydrate. The anhydrous salt forms at 280°C and this decomposes above 500°C . The compound, which was formerly called **white vitriol**, is used as a mordant and as a styptic (to check bleeding).

zinc sulphide A yellow-white water-soluble solid, ZnS. It occurs naturally as *sphalerite (see also ZINC BLENDE) and wurtzite. The compound sublimes at 1180°C. It is used as a pigment and phosphor.

zino See SUPERSYMMETRY.

zircon A naturally occurring silicate of zirconium, ZrSiO₄, used as a gemstone. The colour depends in small amounts of other metals and may be red, brown, yellow, or green. Red gem-quality zircon is sometimes called **jacinth**; gem-quality zircons with other colours are called **jargoons**. There is also a naturally occurring colourless variety. Zircon gems can be given other colours, or made colourless, by heat treatment. The colourless varieties (either natural or treated) are sometimes called **Matura diamonds** (after Matura in Sri Lanka). The name 'zircon' is often erroneously applied to a synthetic form of the oxide *cubic zirconia, which is used as a diamond substitute.

zirconia See ZIRCONIUM.

zirconium Symbol Zr. A grey-white metallic *transition element; a.n. 40; r.a.m. 91.22; r.d. 6.49; m.p. 1852°C; b.p. 4377°C. It is found in zircon (ZrSiO₄; the main source) and in baddeleyite (ZnO₂). Extraction is by chlorination to give ZrCl₄ which is purified by solvent extraction and reduced with magnesium (Kroll process). There are five natural isotopes (mass numbers 90, 91, 92, 94, and 96) and six radioactive isotopes are known. The element is used in nuclear reactors (it is an effective neutron absorber) and in certain alloys. The metal forms a passive layer of oxide in air and burns at 500°C. Most of its compounds are complexes of zirconium(IV). **Zirconium(IV) oxide (zirconia)** is used as an electrolyte in fuel cells. The element was identified in 1789 by Klaproth and was first isolated by Berzelius in 1824.



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zirconium(IV) oxide See ZIRCONIUM.

zodiac A band that passes round the *celestial sphere, extending 9° on either side of the *ecliptic. It includes the apparent paths of the sun, the moon, and the eight major planets of the solar system. The band is divided into the twelve **signs of the zodiac**, each 30° wide. These signs indicate the sun's position each month in the year and were named by the ancient Greeks after the **zodia-**

cal constellations that occupied the signs some 2000 years ago. However, as a result of the *precession of the equinoxes the constellations have since moved eastwards by over 30° and no longer coincide with the signs.

zodiacal light A faint luminous glow in the sky that can be observed on a moonless night on the western horizon after sunset or on the eastern horizon before sunrise. It is caused by the scattering of sunlight by dust particles in interplanetary space.

zonation The distribution of the different species of a community into separate zones, which are created by variations in the environment. A clear example of zonation occurs on a rocky shore, where different species of seaweed (*Fucus*) occupy different zones, according to their ability to withstand desiccation. For example, the species found in the splash zone, which is never completely submerged in water, is better adapted to exposure than those found in zones lower down the shore, where they are submerged for longer periods. Animals, particularly stationary species, such as barnacles, also exhibit zonation on a rocky shore; as with the seaweeds, this may depend on the ability of different species to withstand desiccation. Competition between species may also contribute to zonation.

zone fossil See INDEX FOSSIL.

zone refining A technique used to reduce the level of impurities in certain metals, alloys, semiconductors, and other materials. It is based on the observation that the solubility of an impurity may be different in the liquid and solid phases of a material. To take advantage of this observation, a narrow molten zone is moved along the length of a specimen of the material, with the result that the impurities are segregated at one end of the bar and the pure material at the other. In general, if the impurities lower the melting point of the material they are moved in the same direction as the molten zone moves, and vice versa.

zoogeography The study of the geographical distributions of animals. The earth can be divided into several zoogeographical regions separated by natural barriers, such as oceans, deserts, and mountain ranges. The characteristics of the fauna of each region are believed to depend particularly on the process of *continental drift and the stage of evolution reached when the various

land masses became isolated. For example Australia, which has been isolated since Cretaceous times, has the most primitive native mammalian fauna, consisting solely of marsupials and monotremes. *See also* WALLACE'S LINE.

zoology The scientific study of animals, including their anatomy, physiology, biochemistry, genetics, ecology, evolution, and behaviour.

zooplankton The animal component of *plankton. All major animal phyla are represented in zooplankton, as adults, larvae, or eggs; some are just visible to the naked eye but most cannot be seen without magnification. Near the surface of the sea there may be many thousands of such animals per cubic metre.

zoospore A spore that possesses one or more flagella and is therefore motile. Released from a sporangium (called a **zoosporangium**), zoospores are produced by many algae and certain protists, such as the potato blight (*Phytophthora infestans*).

zwitterion (ampholyte ion) An ion that has a positive and negative charge on the same group of atoms. Zwitterions can be formed from compounds that contain both acid groups and basic groups in their molecules. For example, aminoethanoic acid (the amino acid glycine) has the formula $\text{H}_2\text{N}\cdot\text{CH}_2\cdot\text{COOH}$. However, under neutral conditions, it exists in the form of the zwitterion $^+\text{H}_3\text{N}\cdot\text{CH}_2\cdot\text{COO}^-$, which can be regarded as having been produced by an internal neutralization reaction (transfer of a proton from the carboxyl group to the amino group). Aminoethanoic acid, as a consequence, has some properties characteristic of ionic compounds; e.g. a high melting

point and solubility in water. In acid solutions, the positive ion $^+\text{H}_3\text{N}\cdot\text{CH}_2\cdot\text{COOH}$ is formed. In basic solutions, the negative ion $\text{H}_2\text{N}\cdot\text{CH}_2\cdot\text{COO}^-$ predominates. The name comes from the German *zwei*, two.

zygomorphy *See* BILATERAL SYMMETRY.

Zygomycota A phylum of saprotrophic or parasitic fungi that includes the bread mould (*Mucor*). Their hyphae lack cross walls and they can reproduce asexually by sporangiospores formed within a *sporangium or sexually by means of *zygospores.

zygospore A zygote with a thick resistant wall, formed by some algae and fungi (*see* ZYGOMYCOTA). It results from the fusion of two gametes, neither of which is retained by the parent in any specialized sex organ (such as an oogonium). It enters a resting phase before germination. *Compare* OOSPORE.

zygote A fertilized female *gamete: the product of the fusion of the nucleus of the ovum or ovule with the nucleus of the sperm or pollen grain. *See* FERTILIZATION.

zygotene The second phase of the first *prophase of meiosis, in which *pairing (synapsis) of homologous chromosomes takes place. Intimate contact is made between identical regions of homologues, in a process involving proteins and DNA organized to form a **synaptonemal complex**.

zymogen Any inactive enzyme precursor that, following secretion, is chemically altered to the active form of the enzyme. For example, the protein-digesting enzyme *trypsin is secreted by the pancreas as the zymogen trypsinogen. This is changed in the small intestine by the action of another enzyme, enterokinase, to the active form.