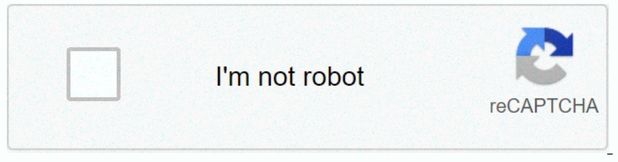

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Molar mass iron atoms

After being mentioned in the atomic mass tutorial, the atomic masses of the different isotopes can be determined to a very high degree of accuracy using mass spectrometry. Iron, with four natural isotopes (54Fe, 56Fe, 57Fe and 58Fe), is no exception. For example, the atomic mass of 54Fe is 53,9396147 u (9 significant digits). The masses of the other iron isotopes are known with the same high degree of precision. The International Union of Pure and Applied Chemistry (IUPAC) Atomic Weights and Isotopic Abundances (CAWAI) Committee on Atomic AndIopies (IUPAC) is responsible for recommending the internationally accepted atomic masses used in the periodic table. This body esteemed by chemists recommends an atomic mass for iron of 55,845 (2) u. Here, the enclosure of the final digit, 2, in the parantheses conveys that this figure is uncertain and therefore not significant. Iron is the final product of stellar nuclear fusion, and the isotopic abundance of iron varies from sample to sample throughout the world, depending on the terrestrial source from which the sample is taken (e.g. pure iron metal vs. mineral deposits or biological samples, geographical origin of the sample, etc.). For example, 56Fe represents 91,742% of iron in human blood, while accounting for 91,760% of iron in some geological formations. It is our uncertainty about the actual absolute isotopic abundance of iron that limits the recommended atomic mass of 55,845 to just 5 significant digits. This article is about the metal element. For other uses, see Iron (disambiguation). Chemical element with atomic number 26 Chemical element with atomic number 26Iron, 26FeIronAppearanceancelloustrous metal with a gray tintIn standard atomic weight Ar, std(Fe)55.845(2)[1]Iron in the periodic table Hydrogen Helium Lithium Berylu Bor carbon Nitrogen Oxygen Fluor neon sodium Magnesium Silicon Fosper Sulf Chlor Argon Potassium Calcium Scandium Titanium Vanad chromium manganese Iron Cobalt Nickel Copper Zinc Galiu Germanium Arsenic Selenium Bromi Krypton Rubidium Strontium Yttrium Zirconiuniu Molibden Technetium Ruthenium Rhodium Palladium Silver Cadmium Indium Staniu Antimonium Telurium Iodine Xenon Ceesiu Bariu Lanthanum Cerium Praseodymium Neodymium Prometium Samarium Euroolium Gadolinium Terbium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium Hafnium Tantalum Tungstennium Osmium Iridium Platinum Gold Mercury (element) Thallium Plumb Bismuth Polonium Astatine Radium Protactinium Uranium PlutoniumIum Curium Berkelium Californium Calcornium Fermium Mendelemium Nobelium Lawrencium Rutherfordium Doublenium Seaborgium Bohrium Hassium Meitnerium Darmstadtium Roentgenium Covertnium Nihonium Flerovium MoscowIum Livermorium → ← Tennesseo Block-Block Category Item Transition MetalElectron Configuration[Ar] 3d6 4s2Electrons per shell2, 8, 14, 2Physical PertePhase to STPsolidMelting STPpaltalate1811 K (1538 °C, 2800 °F) Boiling point3134 K (2862 °C, 5182 °F) Density (near r.t.) 7.874 g/cm3when liquid (at m.p.) 6.98 g/cm3 Fusion heat13.81 kJ/mol Vaporization heat340 kJ/mol Molar thermal capacity25,10 J/(mol• K) Vapour pressure P (Pa) 1 10 100 1 k 10 k 100 k at T (K) 1728 1890 2091 2346 2679 3132 Atomic propertiesEi oxidation states−4, −2, −1, 0, +1,[2] +2, +3, +4, +5,[3] +6, +7[4] (amphoteric oxide)Electronegativity Power scale: 1.83 Ionization energies1st: 762.5 kJ/mol 2nd: 1561.9 kJ/mol 3rd: 2957 kJ/mol (more) Radius empirical atomic: 126 pm Radius CovalentSmall trace: 132±3 pmHigh ray: 152±6 pm Spectral iron linesOther propertiesSuppracticerecurityprimordialPrimary primary structure centered on cubic body (bcc)a=286.65 pmCubic face-centered thermal structure (fcc)between 1185–1667 K; a=364.680 pmThin rod sound speed5120 m/s (at r.t.) (electrolytic) Thermal expansion11,8 µm/(m•K) (at 25 °C) Thermal conductivity80,4 W/(m•K) Electrical resistance9,1 nρ•m (at 20 °C) Curie dot1043 K Magnetic control mode of young people211 GPa Shear Modulus82 GPa Bulk modulus170 GPa Poisson ratio0.29 Mohs hardness4 Vickers hardness608 MPa Brinell hardness200–1180 MPa CAS Number7439-89-6 HistoryDiscoverybefore 1180 MPa CAS Number7439-89-6 HistoryDiscoverybefore 1180 5000 BC Iron Isotopes Isotop Abundance Surrounding (t1/2) Decomposition mode Product 54Fe 5.85% stable 55Fe syn 2.73 y ε 55Mn 56Fe 91.75% stable 57Fe 2.12% stable 58Fe 0.28% stable 59Fe syn 44.6 d β− 59Co 60Fe trace 2.6×106 y β− 60Co Category: Ironviewtalkedit | Iron references is a chemical element with the symbol Fe (from Latin: ferrum) and atomic number 26. It is a metal belonging to the first transition series and group 8 of the periodic table. It is mass the most common element on Earth, right in front of oxygen (32.1% and 30.1% respectively), forming a large part of the outer and inner core of the Earth. It is the fourth most common element in the Earth's crust. In its metallic state, iron is rare in the Earth's crust, limited mainly to deposition by meteorites. Iron ores, by contrast, are among the most abundant in the earth's crust, although extracting usable metals from them requires furnaces or furnaces capable of reaching 1,500 °C (2,730 °F) or higher, about 500 °C (900 °F) higher than required to smell copper. Humans began to master this process in Eurasia only about 2000 BC,[unverified in the body] and the use of iron tools and weapons began to replace copper alloys in some regions, only around 1200 î.Hr. from the Bronze Age to the Iron Age. In the modern world, iron alloys, would be steel, stainless steel, cast iron and special special steels by far the most common industrial metals, because of their mechanical and low cost properties. The clean, smooth, pure iron surfaces are silvery silver ye, mirror-like. However, iron reacts gently with oxygen and water to give brown to black hydrated iron oxides, known as rust. Unlike oxides of other metals, which form passive layers, rust takes up more volume than metal and thus detaches, exposing fresh surfaces for corrosion. The body of an adult man contains about 4 grams (0.005% body weight) of iron, especially in hemoglobin and myoglobin. These two proteins play an essential role in the metabolism of vertebrates, namely the transport of oxygen by storing blood and oxygen in the muscles. To maintain the required levels, the metabolism of human iron requires a minimum of iron in the diet. Iron is also the active metal of many important redox enzymes that deal with cellular respiration and oxidation and reduction of plants and animals. [5] Chemically, the most common states of iron oxidation are iron(II) and iron(III). Iron has many properties of other transitional metals, including other elements of group 8, ruthenium and osmium. Iron forms compounds in a wide range of oxidation states, from −2 to +7. Iron also forms many coordination compounds; some of them, such as the ferrocen, the feroxallate and the Prussian blue, have substantial industrial, medical or research applications. Features Allotopes Main Article: Alotropics of iron molar volume vs. pressure for α iron at room temperature At least four iron allotropics (various atom arrangements in solid) are known, conventionally noted α, γ, δ, and ε. Diagram of the low pressure phase of pure iron The first three forms are observed at normal pressures. As the molten iron cools beyond its freezing point of 1538 °C, it crystallizes into the δ of the aletrope, which has a cubic crystalline structure (bcc) centered on the body. As it cools further to 1394 °C, it changes to its γ-iron alothrope, a cubic crystalline structure centered on the face (FCC) or austenitis. At 912 °C and below, the crystalline structure becomes again the allotropic bcc α-iron. [6] The physical properties of iron at very high pressures and temperatures have also been extensively studied,[7][8] due to their relevance to theories about the nuclei of the Earth and other planets. Over about 10 GPa and temperatures of a few hundred kelvins or less, α-iron changes into another tightly packaged hexagonal structure (hcp), which is also known as ε-iron. The higher temperature γ-phase also turns into ε-iron, but does so at higher pressure. Exists Controversial experimental evidence for a stable phase β at pressures above 50 GPa and temperatures of at least 1500 K. It should have an ortorhomgic or double hcp structure. [9] (Confusingly, the term β-iron is sometimes also used to refer to the α-iron above its Curie point, Curie, changes from being ferromagnetic to paramagnetic, even if its crystal structure has not changed. [6]) The Earth's inner core is generally assumed to consist of an iron-nickel alloy with ε (or β) structure. [10] Melting and boiling points The melting and boiling points of iron, together with the atomization enthalpy, are lower than those of the previous 3d elements from scandium to chromium, showing the diminished contribution of 3d electrons to metal bonding, as they are increasingly attracted to the inert core of the nucleus; [11] however, they are higher than the values for the previous manganese element, since that element has a half-filled 3d subshell and therefore its d-electrons are not easily delocalized. The same trend occurs for ruthenium, but not for osmium. [12] The melting point of iron is well defined experimentally for pressures below 50 GPa. For higher pressures, published data (since 2007) still ranges from tens of gigapascals and over a thousand kelvins. [13] Magnetic properties Magnetization curves of 9 ferromagnetic materials, showing saturation. 1. Steel board, 2. Silicone steel, 3. Cast steel, 4. Tungsten steel, 5. Magnet steel, 6. Cast iron, 7. Nickel, 8. Cobalt, 9. Magnetite[14] Below its Curie point of 770 °C, the α-iron changes from paramagnetic to ferromagnetic: the rotations of the two unpaired electrons in each atom generally align with the rotations of its neighbors, creating a global magnetic field. [15] This is because the orbitals of those two electrons (dz2 and dx2 − y2) do not point to the neighbouring atoms in the lattice and are therefore not involved in the metal bonding. [6] In the absence of an external magnetic field source, atoms are spontaneously divided into magnetic fields, about 10 micrometers in diameter,[16] so that atoms in each field have parallel rotations, but some fields have other orientations. Thus, a macroscopic piece of iron will have a global magnetic field almost zero. The application of an external magnetic field causes the fields that are magnetized in the same general direction to increase to the detriment of adjacent ones pointing in other directions, strengthening the external field. This effect is exploited in devices that must channel magnetic fields, such as electric transformers, magnetic recording heads, and electric motors. Impurities, lattice defects or grain and particle boundaries can fix the fields in the new positions, so that the effect persists even after removal of the external field — thus turning the iron object into a magnet (permanent). [15] A similar behaviour is exhibited by some iron compounds, such as ferrites and mineral magnetitis, a crystalline form of mixed iron oxide (II,III) Fe3O4 (although the mechanism of the atomic scale, ferrimagnetism, somewhat different). Pieces of magnetite with natural permanent magnetization provided that the earliest compasses for navigation. Magnetite particles were widely used in magnetic recording media, such as basic memory, magnetic tapes, floppy disks and discs, until they were replaced by cobalt-based materials. Isotopes Main article: Iron isotopes Iron has four stable isotopes: 54Fe (5.845% natural iron), 56Fe (91.754%), 57Fe (2.119%) and 58Fe (0.282%). 20-30 artificial isotopes were also created. Of these stable isotopes, only 57Fe has a nuclear rotation (− 1/2). The 54Fe nuclide can theoretically undergo a double electron capture at 54Cr, but the process has never been observed and only a lower half-life limit of 3.1×1022 years has been established. [17] 60Fe is a extinct radionuclide with a long half-life (2.6 million years). [18] It is not found on Earth, but its final degradation product is its niece, the stable 60Ni nuclide. [17] Much of the previous work on the isotopic composition of iron has focused on 60Fe nutmeg synthesis through meteorite studies and ore formation. Over the past decade, advances in mass spectrometry have enabled the detection and quantification of minute variations, which occur naturally in the ratios of stable iron isotopes. Much of this activity is driven by earth and planetary scientific communities, although applications for biological and industrial systems occur. [19] In the Semarkona and Chervony Kut meteorite phases, a correlation between the concentration of 60Ni, 60Fe's niece, and the abundance of established iron isotopes provided evidence for the existence of 60Fe at the time of the formation of the Solar System. The energy released by the disintegration of 60Fe, together with that released by 26Al, may contribute to the remelting and differentiation of asteroids after their formation 4.6 billion years ago. The abundance of 60Ni present in extraterrestrial material can bring an additional insight into the early origin and history of the Solar System. [20] The most abundant 56Fe iron isotope is of particular interest to nuclear scientists because it is the most common objective of the nutmeg. [21] Since 56Ni (14 alpha particles) is easily produced from lighter nuclei in the alpha process in nuclear reactions in supernovae (see silicon combustion process), it is the end point of fusion chains inside extremely massive stars, since the addition of another alpha particle, resulting in 60Zn, requires much more energy. This 56Ni, which has a half-life of about 6 days, is created in quantity in these stars, but soon breaks down by two successive emissions of positrons in supernova decay products in the remaining supernova gas cloud, first at 56Co radioactive, and then at 56Fe. As such, iron is the most abundant element in the core of the red giants and is the most abundant metal in the iron meteorites and dense metal nuclei of the planets, would be Earth. [22] [22] also very common in the universe, compared to other stable metals of about the same atomic weight. [22] [23] Iron is the sixth most abundant element in the universe and the most common refractory element. [24] Although another low energy gain could be extracted by synthesizing 62Ni, which has a binding energy marginally greater than 56Fe, the conditions in the stars are not suitable for this process. The production of elements in supernovae and distribution on Earth greatly favors iron over nickel, and in any case, 56Fe still has a smaller mass on the nucleon than 62Ni due to its larger fraction of lighter protons. [25] Therefore, elements heavier than iron require a supernova for their formation, involving the rapid capture of neutrons by starting 56Fe nuclei. [22] In the distant future of the universe, assuming that the decay of protons does not occur, the cold fusion that occurs through quantum tunneling would make the light nuclei of ordinary matter merge into 56Fe nuclei. Fission and emission of alpha particles would then make heavy-core to decompose into iron, converting all stellar mass objects into cold spheres of pure iron. [26] The origin and appearance in nature of the abundance of Iron's Cosmogenesis on rocky planets such as Earth is due to its abundant production during the fusion and explosion of type Ia supernova, which scatters iron in space. [27] Metallic iron A polished and chemically engraved piece of an iron meteorite, believed to be similar in composition to the Earth's metal core, showing individual crystals of the iron-nickel alloy (Widmanstatten model). Metallic or native iron is rarely found on the Earth's surface, as it tends to oxidize. However, both the Earth's inner and outer core, which accounts for 35% of the mass of the entire Earth, is believed to consist largely of an iron alloy, possibly nickel. Electrical currents in the liquid outer core are considered to be the origin of the Earth's magnetic field. Other terrestrial planets (Mercury, Venus and Mars) as well as the Moon are thought to have a metal core made up largely of iron. Type M asteroids are also considered to be partly or largely made of metal iron alloy. Rare iron meteorites are the main form of natural metal iron on the Earth's surface. Cold-worked meteorite iron objects have been found in various archaeological sites dating back to a period when the melting of iron had not yet been developed; and the Inuit in Greenland were reported to use iron from the Cape York meteorite for tools and hunting weapons. [29] Approximately 1 in 20 meteorites consist of the unique minerals of iron-nickel taenice (35-80% iron) and kamacite (90-95% iron). [30] Native iron is, Also rarely found in basalts that formed magma matoms that came into contact with carbon-rich sedimentary rocks, which reduced the fugacity of oxygen enough for the iron to crystallize. This is known as Teluric iron and described in several localities, such as Disko Island in West Greenland, Yakutia in Russia and Bühl in Germany. [31] Ferropericlass mantle minerals (Mg,Fe)O, a solid solution of periclease (MgO) and wüstit (FeO), account for about 20% of the volume of the Earth's lower mantle, making it the second most abundant mineral phase in that region, after silicate perovdit (Mg,Fe)SiO3; is also the major host for iron in the lower mantle. [32] At the bottom of the transition zone of the mantle, the reaction γ-(Mg,Fe)2[SiO4] ↔ (Mg,Fe)[SiO3] + (Mg,Fe)O transforms γ-olivine into a mixture of silica and ferropericlass perovdit and vice versa. In the literature, this mineral phase of the lower mantle is also often called magnesiowüstite. [33] Silicate perovskit can form up to 93% of the lower mantle,[34] and the magnesium iron form, (Mg,Fe)SiO3, is considered to be the most abundant mineral on Earth, which accounts for 38% of its volume. [35] The ochre path of the earth's crust in Roussillon. While iron is the most abundant element on Earth, most of this iron is concentrated in the inner and outer nuclei. [36] [37] The iron fraction in the Earth's crust amounts to only about 5% of the total mass of the crust and is thus only the fourth most abundant element in that layer (after oxygen, silicon and aluminum). [38] Most of the iron in the crust is combined with various other elements to form many iron minerals. An important class are iron oxide minerals, such as hematite (Fe2O3), magnetite (Fe3O4) and siderite (FeCO3), which are the major ores of iron. Many igneous rocks also contain pyrrhotite and pentlandite sulfuric minerals. [39] [40] During weathering, iron tends to leach from sulphide deposits as sulphate and silicate deposits as bicarbonate. Both are oxidized in aqueous solution and precipitate even in slightly high pH as iron oxide (III). [41] Iron training in McKinley Park, Minnesota. Large iron deposits are striped iron formations, a type of rock consisting of repeated thin layers of iron oxides alternating with iron-poor shale and chert strips. Iron formations were established between 3,700 million years ago and 1,800 million years ago. [42] [43] Materials containing finely ground iron oxides(III) or oxides-hydroxydes, such as ochre, have been used as yellow, red and brown pigments since the pre-historic period. They also contribute to the color of various rocks and clays, including entire geological formations, such as the Oregon Painted Hills and Buntsandstein (colored sandstone, British Bunter). [44] By Eissensandstein (a Jurassic iron sandstone, for example from Donzdorf in Germany)[45] and stone in the UK, iron compounds are responsible for the yellowish color of many historic buildings and sculptures. [46] The proverbial red color of the surface of Mars is derived from regolith rich in iron oxide. [47] Significant amounts of iron occur in mineral pyrite iron sulphide (FeS2), but it is difficult to extract iron from it and is therefore not exploited. In fact, iron is so common that production generally focuses only on ores with very large amounts of it. According to the International Resource Panel's Metal Stocks in Society report, the global stock of iron used in the company is 2,200 kg per capita. More developed countries differ in this respect from less developed countries (7,000–14,000 vs. 2,000 kg per capita). [48] Chemistry and compounds See also: Category:Iron compounds. Oxidation status Representative compound −2 (d10) Disodium tetracarbonilferate (collman reagent) −1 (d9) Fe2(CO)2−8 0 (d8) Iron pentacarbonyl 1 (d7) Cyclopentadienil dicarbonyl dimanyl dimer (Fp2) 2 (d6) Ferrous sulphate, ferrocen 3 (d5) Ferric chloride, ferocenium tetrafluoroborate 4 (d4) Fe(diars)2Cl2+2 5 (d3) FeO3−4 6 (d2) Potassium ferrat 7 (d1) [FeO4]– (registered isolation, 4K) Iron exhibits the characteristic chemical properties of transition metals, i.e. the ability to form variable oxidation states which differ in stages of one and very high coordination and organometallic chemistry: indeed, the discovery of an iron compound, the ferocious, revolutionized the latter field in the 1950s. [49] Iron is sometimes considered a prototype for the entire block of transitional metals, due to its abundance and the immense role it has played in the technological advancement of humanity. [50] Its 26 electrons are arranged in configuration [Ar]3d64s2, of which 3d and 4s electrons are relatively close in energy, and thus may lose a variable number of electrons and there is no clear point at which subsequent ionization becomes unprofitable. [12] Iron forms compounds mainly in oxidation states +2 (iron(II), ferrous) and +3 (iron(III), ferric). Iron also occurs in higher oxidation states, for example, purple potassium iron (K2FeO4), which contains iron in its oxidation state +6. Although iron oxide (VIII) (FeO4) was claimed, the ratio could not be reproduced and it was found that such a species from the removal of all electrons of the element beyond the previous configuration of inert gas (at least with iron in its oxidation state +8) proved to be computationally improbable. [51] However, a form of anionic [FeO4]– with iron in its oxidation state +7, together with an iron(V)-peroxo isomer, was detected by infrared spectroscopy at 4 K after the coconding of the ablated laser fe atoms with a mixture of O2/Ar.[52] Iron(IV) is a common intermediate in many biochemical oxidation reactions. [53] [54] Many organoiron compounds contain formal oxidation states of +1, 0, −1 or even −2. Oxidation states and other are often evaluated using the Mössbauer spectroscopy technique. [55] Many mixed valences contain both iron (II) and iron(III) centres, such as magnetite and Prussian blue [Fe4(Fe[CN]6]3]). [54] The latter is used as traditional blue in the plans. [56] Iron is the first of the transition metals that cannot achieve the oxidation state of its +8 group, although its heavier congeners ruthenium and osmium can, with ruthenium having more difficulties than osmium. [6] Rutnium exhibits an aqueous cationic chemistry in its low oxidation states, similar to that of iron, but osmium does not, favoring the high oxidation states in which it forms anionic complexes. [6] In the second half of the 3d transition series, the vertical similarities in the groups compete with the horizontal similarities of iron with its cobalt and nickel neighbors in the periodic table, which are also ferromagnetic at room temperature and share similar chemistry. As such, iron, cobalt and nickel are sometimes grouped together as the iron triad. [50] Unlike many other metals, iron does not form mercury amalgams. As a result, mercury is marketed in standardised 76-pound (34 kg) iron vials. [57] Iron is by far the most reactive element in its group; is pyropholy when finely divided and dissolves slightly into diluted acids, giving Fe2+. However, it does not react with concentrated nitric acid and other oxidizing acids due to the formation of a layer of impermeable oxide, which can nevertheless react with hydrochloric acid. [6] Binary compounds Oxides and hydroxides Ferrous oxide or iron(II), FeO.Feric or iron oxide(III) Fe2O3.Ferroric oxide or iron(II,III) Fe3O4. Iron forms different oxide and hydroxide compounds; the most common are iron oxide (II,III) (Fe3O4) and iron oxide (III) (Fe2O3). Iron oxide (II) also exists, although it is unstable at room temperature. Despite their names, they are actually all non-stoichiometric compounds whose compositions may vary. [58] These oxides are the main minerals for iron production (see bloomery and furnace). They are also used in the production of ferrite, magnetic storage media useful in computers, and pigments. The best known sulphide is iron pyrite (FeS2), also known as stupid gold due to its golden sheen. [54] It is not an iron(IV) compound, but it is actually an iron(II) polysulphide containing Fe2+ and S2−2 ions in a distorted sodium chloride structure. [58] The Pourbaix diagram of Hoxides Hydrated iron chloride (III) (feric chloride) Ferrous and ferric halids are well known. Ferrous halids usually occur from the treatment of iron metals with the appropriate hydrohalic acid to give the appropriate hydrated salts. [54] Fe + 2 HX → FeX2 + H2 (X = F, Cl, Br, I) Iron reacts with fluoride, chlorine and bromine to give happy halids ferric chloride being the most common. [59] 2 Fe + 3 X2 → 2 FeX3 (X = F, Cl, Br) Ferric Iodide is an exception, being thermodynamically unstable due to Fe3+ power and high reduction power of I−:[59] 2 I− + 2 Fe3+ → I2 + 2 Fe2+ (E0 = +0.23 V) Ferric iodide, a black solid, is not stable under normal conditions, but can be prepared by the reaction of iron pentacarbonyl with iodine and carbon monoxide in the presence of hexane and light at temperature of −20 °C, with oxygen and water excluded. [59] Chemistry solution Comparison of the colors of the iron solutions (left) and permanganate (right) The standard potential for reduction in acidic aqueous solution for some common iron ions are shown below:[6] Fe2+ + 2 e− • Fe E0 = −0.447 V Fe3+ + 3 e− Fe E0 = −0.037 V FeO2−4 + 8 H+ + 3 e− Fe3+ + 4 H2O E0 = +2.20 V Red-violet tetraedral ferrat(VI) is an oxidising agent so strong that it oxidizes nitrogen and ammonia at room temperature , and even wet in acidic or neutral solutions:[59] 4 FeO2−4 + 10 H2O → 4 Fe3+ + 20 OH− + 3 O2 The Fe3+ Ion has a large simple cationic chemistry, although the pale violet hexaquo ion [Fe(H2O)6]3+ is very easily hydrolyzed when the pH rises above 0, after following:[60] [Fe(H2O)6]3+ [Fe(H2O)5(OH)]] 2+ + H+ K = 10−3 ,05 mol dm−3 [Fe(H2O)5(OH)]2+ [Fe(H2O)4(OH)2]+ + H+ K =

10−3.26 mol dm−3 2[Fe(H2O)6](3+))] [Fe(H2O)4(OH)]4+2 + 2H+ + 2H2O K = 10−2.9 1 mol dm−3 Blue-green iron sulphate(II) heptahydrate as the pH rises above 0, the yellow hydrolysed species above are formed and rise above 2–3 , red-brown-brown(III) hydrous iron oxide is precipitated from the solution. Although Fe3+ has a d5 configuration, its absorption spectrum is not similar to that of Mn2+ with its weak d-d bands, prohibited by spin, because Fe3+ has a higher positive load and is more polarizing, reducing the energy of its ligand-to-metal load transfer removals. Thus, all the above complexes are quite strongly colored, with the unique exception of the hexaquo ion – and even that it has a spectrum dominated by load transfer in the nearby ultraviolet region. [60] On the other hand, pale green iron(II) hexaquo ion [Fe(H2O)6]2+ is not subjected to appreciable hydrolysis. Carbon dioxide is not evolved when carbonate anions are added, which instead leads to the precipitation of white iron carbonate (II). In excess of carbon dioxide, it forms the easily soluble bicarbonate, which frequently occurs in groundwater, but oxidizes rapidly in the air to form iron oxide (III) which represents the brown deposits present in a considerable number of streams. [61] Coordinating compounds Due to its electronic structure, iron has very high coordination and organometallic chemistry. The two enantiomorphics of feroxalate ion Many iron coordinating compounds are known. A typical anion with six coordinates is hexachloriferrate(III), [FeCl6]3−, found in the mixed chloride of tetrachis (methylammonium) hexachlorrate(III). [62] [63] Multi-Bidencomplex complexes have geometric isomers. For example, the trans-chlorohhydridobis(bis-1,2-(diphenylphosphomino)ethane) iron(II) complex is used as the base material for Fe(dppe)2 moiety compounds. [64] [65] The three-oxalate ligand ion (shown on the right) displays the helical chirality with the two non-supeponable geometries labeled lambda) for the left-handed screw axis and the right-handed screw axis, in accordance with iUPAC conventions. [60] Potassium ferioxalate is used in chemical actinometry and together with its sodium salt undergoes photoreduction applied in old-style photographic processes. The iron oxalate dihydrate (II) has a polymeric structure with co-planar oxalate ions that connect the iron centers to the crystallization water located forming the caps of each octahedron, as shown below. [66] The crystalline structure of oxalate iron(II) atoms, which have iron (grey), oxygen (red), carbon (black) and hydrogen (white) atoms. The red-blood positive tiocyanate test for iron(III) iron(III) complexes is quite similar to those of chromium(III), with the exception of iron(III) preference for the O donor instead of N donor ligands. Many Fe-O complexes show intense colors and are used as tests for phenols or enols. For example, in the ferric chloride test, used to determine the presence of phenols, Iron chloride(III) reacts with a phenol to form a deep purple complex:[60] 3 ArOH + FeCl3 → Fe(OAr)3 + 3 HCl (Ar = aril) Among halid and pseudohalid complexes, iron(III) fluoro complexes are the most stable, colorless [FeF5(H2O)]2− being the most stable in aqueous solution. The chloro complexes are less stable and favour tetraedral coordination as in [FeCl4]−; [FeBr4]− and [FeI4]− are easily reduced to iron(II). Tiocyanate is a common test for the presence of iron(III) because it forms red-blood [Fe(SKN)(H2O)5]2+. Like manganese(II), most iron(III) complexes are high spin, the exceptions being those with ligands that are raised in the spectrochemical series, would be cyanide. An example of a low-spin iron(III) complex is [Fe(CN)6]3−. Cyanide ligands can be easily broken down in [Fe(CN)6]3−, and therefore this complex is poisonous, unlike the iron(II) complex [Fe(CN)6]4− found in Prussian blue,[60] which does not release hydrogen cyanide unless dilute acids are added. [61] Iron has a wide variety of electronic rotation states, including each possible quantum rotation number value for a block element d from 0 (diamagnetic) to 5/2 (5 non-associated electrons). This value is always half the number of unpaired electrons. with zero to two unassociated electrons are considered low spin, and those with four or five are considered high spin. [58] Iron complexes (II) are less stable than iron complexes(III), but for donor ligands O is less marked, so, for example, [Fe(NH3)6]2+ is known while [Fe(NH3)6]3+ is not known. They tend to be oxidized to iron (III), but this may be moderated by the low pH and specific ligands used. [61] Organometallic compounds The chemistry of the organoiron of penta-carbonyl iron is the study of organometallic compounds of iron, where carbon atoms are covalently bound to the metal atom. They are many and varied, including cyanide complexes, carbonyl complexes, sandwich and semi-sandwich compounds. Prussian blue prussian blue blue or ferric ferrocyanide, Fe4[Fe(CN)6]3, is an old and well-known complex of iron cyanide, widely used as pigment and in several other applications. Its formation can be used as a simple wet chemistry test to distinguish between aqueous solutions of Fe2+ and Fe3+ as it reacts (i.e.) with potassium ferricianide and potassium ferrocyanide to form Prussian blue. [54] Another ancient example of an organoiron compound is iron pentacarbonyl, Fe(CO)5, in which a neutral iron atom is linked to the carbon atoms of five carbon monoxide molecules. The compound can be used to make carbonyl iron powder, a highly reactive form of metal iron. The thermolysis of iron pentacarbonyl gives triiron dodecacarbonyl, Fe3(CO)12, with a group of three iron atoms at its center. Collman reagent, disodium tetracarbonylferate, is a useful reagent for organic chemistry; contains iron in the oxidation state −2. Cyclopentadieniliron dicarbonyl dimer contains iron in a rare oxidation state +1. [67] The structural formula of the pherocen and a powdered sample A landmark in this field was the discovery in 1951 of the remarkably stable ferocious sandwich compound Fe(C5H5)2, by Paulson and Kealy[68] and independent lysed by Miller and others,[69] whose surprising molecular structure was determined only a year later by Woodward and Wilkinson[70] and Fischer. [71] The Ferocen is still one of the most important instruments and models in this class. [72] Iron-centered organometallic species are used as catalysts. The Knölker complex, for example, is a transfer hydrogenation catalyst for ketones. [73] Industrial uses Iron compounds produced at the largest scale in the industry are iron sulphate (II) (FeSO4•7H2O) and iron chloride (III) (FeCl3). The first is one of the most available sources of iron(II), but is less stable at aerial oxidation than Mohr's salt ((NH4)2Fe(SO4)2•6H2O). Iron compounds (II) tend to be oxidized into iron compounds (III) in the air. [54] Etymology of iren, an ancient English word for iron Since iron has been used for so long, has many names. The source of its chemical symbol Fe is the Latin word ferrum, and its descendants the name of the element in Romance languages (e.g. French fer, Spanish hierro and Italian and Portuguese fero). [74] The word ferrum itself possibly comes from the Semitic languages, through from a root that also gave rise to old Brass English bræs. [75] The English word iron eventually derives from proto-Germanic *isarnan, which is also the source of the German name Eisen. It was most likely borrowed from Celtic *isarnon, which ultimately comes from Proto-Indo-European *is-(e)ro- strong, holy and ultimately *strong eis, referring to the power of iron as metal. [76] Kluge recounts *isarnon with Iliric and Latin ira, anger). [citation required] The Balto-Slavic name for iron (e.g. Russian zhelezo, Polish żelazo, Lithuanian geležis) are the only ones that come directly from Proto-Indo-European *ghelgh-iron. [77] In many of these languages, the word for iron can also be used to designate other objects of iron or steel, or figuratively because of the hardness and strength of the metal. [78] The Chinese Tiě (traditionally 鐵; simplified) comes from proto-sino-Tibetan *hliek, [79] and was borrowed in Japanese as tetsu, which also has native reading kurokane black metal (similar to how iron is mentioned in the English word blacksmith). [80] History Main article: The history of ferrous metallurgy The development of iron metallurgy iron is one of the undoubtedly known elements in the ancient world. [81] It has been worked, or forged, for millennia. However, high-age iron objects are much rarer than gold or silver objects due to the ease with which iron corrodes. [82] Technology developed slowly, and even after the discovery of melting it took many centuries for iron to replace bronze as the chosen metal for tools and weapons. Greenland's meteorite iron harpoon head. The iron edge covers a narwhal harpoon with fangs using meteorite iron from the Cape York meteorite, one of the largest known iron meteorites. Beads made of meteoric iron in 3500 î.Hr. or earlier were found in Gerzah, Egypt by G.A. Wainwright. [83] Beads contain 7.5% nickel, which is a signature of meteoric origin, since the iron found in the Earth's crust generally has only tiny nickel impurities. Meteoric iron was highly appreciated due to its origin in the heavens and was often used to forge weapons and tools. [83] For example, a meteoric iron dagger was found in Tutankhamun's tomb, containing similar proportions of iron, cobalt and nickel with a meteorite discovered in the area, deposited by an ancient meteor shower. [84] [85] [86] Objects that were likely made of iron by the Egyptians date back to 3000 to 2500 î.Hr. [82] Meteorite iron is comparably soft and ductile and easy to forge cold, but can be brittle when heated due to its nickel content. [87] Forged Iron Main Article: Forged Iron Additional Information: Ancient Iron Symbol for Mars has been used since ancient times to represent iron. The Iron Pillar of Delhi is an example of iron extraction and methodologies in early India. First iron began in the Middle Bronze Age, but lasted several centuries before the iron displaced bronze. Samples of molten iron from Asmar, Mesopotamia and Chagar High Bazaar in northern Syria were taken sometime between 3000 and 2700 î.Hr. [88] The Hittites established an empire in northern-central Anatolia around 1600 î.Hr. [89] The Hittites began to smell iron between 1500 and 1200 î.Hr., and the practice spread to the rest of the Near East after their empire fell in 1180 î.Hr. [88] The following period is called the Iron Age. Melted iron artifacts are found in India dating from 1800 to 1200 BC,[90] and in the Levant from about 1500 î.Hr. (suggesting melting in Anatolia or the Caucasus). [91] [92] Alleged references (comparing the history of metallurgy in South Asia) to iron in the Indian Vedas were used for claims of very early use of iron in India, i.e. to date, the texts as such. The term rigveda ayas (metal) probably refers to copper and bronze, while iron or śyāma ayas, literally black metal, is mentioned first in post-rigvedic atharvaveda. [93] Some archaeological evidence suggests that iron was melted in Zimbabwe and southeastern Africa as early as the 8th century î.Hr. [94] Iron processing was introduced in Greece at the end of the 11th century î.Hr., from where it spread rapidly throughout Europe. [95] Iron sickle from Ancient Greece. The spread of iron in Central and Western Europe is associated with Celtic expansion. According to Plini the Elder, the use of iron was common in the Roman era. [83] The annual iron production of the Roman Empire is estimated at 84,750 t,[96] while similar China inn and contemporary produced about 5000 t.[97] In China, iron only occurs around 700-500 î.Hr. [98] Melting iron could have been introduced in China through Central Asia. [99] The earliest evidence of the use of a furnace in China dates back to the 1st century AD,[100] and dome furnaces have been used since the warring states (403-221 î.Hr.). [101] The use of the dome oven and the dome oven remained widespread during the Song and Tang dynasties. [102] During the Uk Industrial Revolution, Henry Cort began refining iron from pig iron to wrought iron (or bar iron) using innovative production systems. In 1783 he patented the puddling process for refining iron ore. It was later improved by others, including Joseph Hall. [103] Font Main article: Fonta was first produced in China in the 5th century BC,[104] but was hardly in Europe until the medieval period. [105] [106] The oldest cast iron artifacts were by archaeologists in what is now modern Luhe County, Jiangsu in China. Fonta was used in ancient China for war, agriculture and architecture. [107] In the medieval period, the means were found in Europe production of wrought iron made of cast iron (in this context known as pig's iron) using fine forgings. For all these processes, coal was required as fuel. [108] Coalbrookdale by Night, 1801. The furnaces light up the iron-processing town of Coalbrookdale. Medieval furnaces were about 3.0 m high and were made of fireproof brick; forced air was usually provided by hand-operated bellows. [106] Modern furnaces have grown much larger, with a hearth with a diameter of fourteen meters, which allow them to produce thousands of tons of iron every day, but operate essentially in the same way as in the medieval period. [108] In 1709, Abraham Darby I established a coke furnace to produce cast iron, replacing coal, although it continued to use furnaces. The subsequent availability of cheap iron was one of the factors that led to the Industrial Revolution. Towards the end of the 18th century, cast iron began to replace wrought iron for certain purposes because it was cheaper. The iron carbon content was not involved as a reason for the differences in the properties of wrought iron, cast iron and steel until the 18th century. [88] As iron became increasingly cheap and abundant, it also became a major structural material after the construction of the first innovative iron bridge in 1778. This bridge is still a monument to the role played by iron in the Industrial Revolution. Subsequently, iron was used in wheels, boats, ships, aqueducts and buildings, as well as in iron cylinders in steam engines. [108] Railways were essential for the formation of modernity and ideas of progress[109] and different languages (e.g. French, Spanish, Italian and German) refer to railways as iron roads. Steel main article: Steel See also: Steel steel processing (with a lower carbon content than pork iron, but more than wrought iron) was first produced in antiquity by using a bloomery. Blacksmiths in Luristan, western Persia, made good steel by 1000 î.Hr. [88] Then improved versions, Wootz Steel of India and Damascus Steel were developed around 300 î.Hr., respectively 500 d.Hr. [110] New methods of producing it by carbide iron bars in the cementing process were conceived in the 17th century. In the Industrial Revolution, new methods of coal-free iron production were designed and were later applied to produce steel. In the late 1850s, Henry Bessemer invented a new steel-making process, involving blowing air through molten pork iron to produce light steel. This made steel much which led to the fact that wrought iron is no longer produced in large quantities. [111] The basics of modern chemistry In 1774, Antoine Lavoisier used the reaction of the steam of water with metal iron inside an incandescent iron tube to produce in his experiments that led to the demonstration of mass conservation, which played a key role in changing chemistry from qualitative to quantitative science. [112] Symbolic role Gold gab ich für Eisen – I gave gold for iron. German-American brooch from World War I. Iron plays a certain role in mythology and has found different uses as a metaphor and in folklore. The works and days of the Greek poet Hesiod (lines 109-201) list different epochs of man named after metals such as gold, silver, bronze and iron to take into account the successive ages of humanity. [113] The Iron Age was closely related to Rome, and in the Metamorphoses of Ovidiu virtues, in despair, he left the earth; and man's depravity becomes universal and complete. Heavy steel succeeded then.- Ovidium, Metamorphoses, Book I, Iron Age, line 160 ff An example of the importance of the symbolic role of iron can be found in the German campaign of 1813. Frederick Wilhelm III then commanded the first Iron Cross as military decoration. The iron jewels in Berlin reached the peak of production between 1813 and 1815, when the Prussian royal family asked citizens to donate gold and silver jewelry for military funding. The inscription Gold gab ich für Eisen (I gave him gold for iron) was also used in later war efforts. [114] Production of laboratory-based iron metal powder For a few limited purposes, when necessary, pure iron is produced in the laboratory in small quantities by reducing pure oxide or hydrogen hydroxide or forming iron pentacarbonyl and heating it to 250 °C so that it decomposes to form pure iron powder. [41] Another method is the electrolysis of ferrous chloride on an iron cathode. [115] Main industrial route See also: Iron Production 2009 (million tonnes)[116] Iron Country Iron Direct Iron Iron China 1,114.9 549.4 573.6 Australia 393.9 4.4 5.2 Brazil 305.0 25.1 0.011 26.5 Japan 66.9 87.5 India 25 7.4 38.5 2 23.4 63.5 Russia 92.1 43.9 4.7 60.0 Ukraine 65.8 25.7 29.9 South Korea 0.1 27.0 3 48.6 Germany 0.4 20.1 0.38 32.7 World 1,594.9 914.0 64.5 1.232.4 Today , industrial production of iron or steel consists of two main stages. In the first stage, iron ore is reduced with coke in a furnace, and the molten metal is separated from the raw impurities, would be silicate minerals. This stage produces an alloy - pig's iron - containing relatively large amounts of carbon. In the second stage, the amount of carbon in pig iron is reduced by oxidation to produce wrought iron, steel or cast iron. [117] Other metals can be added at this stage to form alloy steels. 17th-century Chinese illustration of workers in a furnace, making wrought iron from iron iron was extracted in the 19th century Furnace processing Main article: The furnace is loaded with iron ores, usually fe2O3 hematite or Fe3O4 magnetite, along with coke which has been baked separately to remove volatile components). Preheated air at 900 °C is blown through the mixture, in a quantity sufficient to convert carbon into carbon monoxide:[117] 2 C + O2 → 2 CO This reaction raises the temperature to about 2000 °C Carbon monoxide reduces iron ore to metal iron[117] Fe2O3 + 3 CO → 2 Fe + 3 CO2 Some iron in the lower region of the high temperature furnace reacts directly with coke :[117] 2 Fe2O3 + 3 C → 4 Fe + 3 CO2 A stream, such as limestone (calcium carbonate) or dolomite (calcium-magnesium carbonate) is also added to the load of the furnace. Its purpose is to remove silicaous minerals in ore, which would otherwise block the furnace. The heat of the furnace breaks down the carbonates into calcium oxide, which reacts with any excess silicon to form a slag composed of calcium silicate CaSiO3 or other products. At oven temperature, the metal and slag are melted. They collect at the bottom as two layers of imiscible liquids (with slag on top), which are then easy to separate. [117] Clay can be used as a material in road construction or to improve mineral-poor soils for agriculture. [106] This pile of iron ore pelts will be used in steel production. Manufacture of steel Main articles: Steelworks and Ironworks A molten iron pot being used to make steel In general, pork iron produced by the furnace process contains up to 4-5% carbon, with small amounts of other impurities, such as sulfur, magnesium, phosphorus and manganese. High carbon levels make it relatively weak and fragile. Reducing the amount of carbon to 0.002–2.1% of the mass-producing steel, which can be up to 1000 times heavier than pure iron. A wide variety of steel articles can then be made by working cold, hot rolling, forging, processing, etc. The removal of other impurities, in turn, leads to cast iron, which is used to throw items in the foundries; e.g. stoves, pipes, radiators, lamps and wells. [117] Steel products are often subjected to various heat treatments after they are forged to form. Reanimation consists of heating them to 700-800 °C for several hours and then gradual cooling. Makes steel softer and more work-resistant. [119] Direct iron reduction Due to environmental problems, alternative methods of iron processing have been developed. Direct reduction of iron reduces iron ore to a ferrous lump called sponge iron or direct iron that is suitable for the manufacture of steel. [106] Two main reactions include the direct reduction process: Natural gas is partially oxidized (with heat and catalyst):[106] 2 CH4 + O2 → 2 CO + 4 H2 Iron ore is then treated with these gases in an oven, producing solid sponge:[106] Fe2O3 + CO + 2 H2 → 2 Fe + CO2 + 2 H2O Silica is removed by adding a stream of limestone as described above. [106] Termite process Main article: Lighting the termite of an aluminum mixture and iron oxide produces metal iron by the termite reaction: Fe2O3 + 2 Al → 2 Fe + Al2O3 Alternatively, pig iron can be converted into steel (with up to about 2% carbon) or wrought iron (pure commercial iron). Various processes have been used for this, including forery forgings, puddling furnaces, Besserer converters, open hearth ovens, basic oxygen ovens, and arc furnaces. In all cases, the objective is to oxidize some or all of the carbon along with other impurities. On the other hand, other metals can be added to make alloy steels. [108] Applications As a structural material Iron is the most widely used of all metals, accounting for over 90% of the world's metal production. Its low cost and high strength often make material of choice material to withstand stress or transmit forces, such as the construction of machinery and machine tools, rails, automobiles, hull of the ship, concrete reinforcement bars, and the loading frame of buildings. Since pure iron is quite soft, it is most commonly combined with alloy elements to make steel. [120] Mechanical properties Characteristic values of tensile strength (TS) and Brinell hardness (BH) of different forms of iron. [121] [122] Material TS (MPa) BH (Brinell) Iron whiskers 11000 Ausformat steel (hardened) 2930 850–1200 Martensitic steel 2070 600 Bainitic steel 1380 400 Pearly steel 1200 350 Cold-processed iron 690 200 Small grain iron 340 100 Carbon-containing iron 140 40 Pure, single crystal iron 10 3 Mechanical properties of iron and its alloys are highly relevant to their structural applications. These properties can be evaluated in various ways, including the Brinell test, the Rockwell test and the Vickers hardness test. The properties of pure iron are often used for calibrating measurements or comparing tests. [122] [123] However, the mechanical properties of iron are significantly affected by the purity of the sample: pure and single iron crystals are actually softer than aluminium,[121] and the purest industrial iron (99.99%) has a hardness of 20-30 Brinell. [124] An increase in carbon content will cause a significant increase in iron hardness and tensile strength. The maximum hardness of 65 Rc is achieved with a carbon content of 0.6%, although the alloy has low tensile strength. [125] Due to the softness of iron, it is much easier to work with its heavier congeners ruthenium and osmium. [12] Iron-carbon phase diagram Types of steels and alloys See also: Steel α-Fier is a fairly soft metal that can dissolve only a low concentration of carbon (no more than 0.021% of the mass at 910 °C). [126] Austenitis (γ-iron) is equally soft and metallic, but can dissolve considerably more carbon 2.04% by mass at 1146 °C). This form of iron is used in the type of stainless steel used for the manufacture of cutlery, as well as hospital equipment and food services. [16] [16] available iron is classified on the basis of the purity and abundance of additives. Pork iron has 3.5–4.5% carbon[127] and contains different amounts of contaminants, such as sulphur, silicon and phosphorus. The font is not a marketable product, but rather an intermediate step in the production of cast iron and steel. Reduction of contaminants in pig iron that adversely affect the properties of materials, such as sulfur and phosphorus, produces cast iron containing 2-4% carbon, silicon 1-6% and small amounts of manganese. [117] Pork iron has a melting point between 1420 and 1470 K, which is smaller than either of its two main components, and makes it the first molten product when carbon and iron are heated together. [6] Its mechanical properties vary greatly and depend on the shape carbon takes in the alloy. [12] White fonts contain carbon in the form of cementite or iron carbide (Fe3C). [12] This hard and fragile compound dominates the mechanical properties of white fonts, making them harsh but non-shock-resistant. The broken surface of a white cast is full of fine facets of the broken iron carbide, a very pale, silvery, shiny material, hence the name. Cooling an iron mixture with 0.8% carbon slowly below 723 °C leads to room temperature in separate layers, alternative to cementite and α-iron, which is soft and malleable and is called perlite for its appearance. Rapid cooling, on the other hand, does not allow time for this separation and creates hard and fragile martensites. Steel can then be tempered by reheating to a temperature between them, changing the proportions of perlite and martensite. The final product below 0.8% carbon content is a mixture of perlite-αFe, and the carbon content of more than 0.8% is a mixture of perlite-cementite. [12] In grey iron carbon exists as separate flakes, fine graphite, and also makes the material brittle due to the sharp graphite cut flakes that produce places of stress concentration within the material. [128] A newer variant of grey iron, called ductile iron, is specially treated with traces of magnesium to alter the shape of graphite into spheroids, or nodules, reducing stress concentrations and greatly increasing the hardness and strength of the material. [128] Forged iron contains less than 0.25% carbon, but large amounts of slag that give it a fibrous characteristic. [127] It is a hard, malleable product, but not as fusible as pork iron. If it perfects to the edge, it loses quickly. Forged iron is characterized by the presence of fine slag fibers trapped in the metal. Forged iron is more resistant to corrosion than steel. It has almost completely been replaced with light steel for traditional wrought iron products and blacksmith. Light steel corrodes more easily than wrought iron, but is cheaper and more Widely. Carbon steel contains carbon or less,[129] with small amounts of manganese, sulphur, phosphorus and silicon. Allied steels contain different amounts of carbon, as well as other metals, such as chromium, vanadium, molybdenum, nickel, tungsten, etc. Their alloy content increases their cost, and so they are usually used only for specialized uses. A common steel alloy, though, is stainless steel. Recent developments in ferrous metallurgy have produced a growing range of microalloy steels, also called HSLA or high-strength, low-alloy steels, which contain small additions to produce high strength and often spectacular resistance at minimal cost. [129] [130] [131] The coefficient of attenuation of the mass of photons for iron. In addition to traditional applications, iron is also used for protection against ionizing radiation. Although it is lighter than another traditional protective material, lead, it is much more powerful mechanically. Radiation attenuation according to energy is shown in the graph. [132] The main disadvantage of iron and steel is that pure iron, and most of its alloys, suffers severely from rust if not protected in some way, a cost that amounts to more than 1% of the world's economy. [133] Painting, galvanizing, passing, plastic coating and bluing are all used to protect rust iron by excluding water and oxygen or by cathode protection. The mechanism of iron rusting is as follows:[133] Cathode: 3 O2 + 6 H2O + 12 e− → 12 OH− Anode: 4 Fe → 4 Fe2+ + 8 e−; 4 Fe2+ → 4 Fe3+ + 4 e− Overall: 4 Fe + 3 O2 + 6 H2O → 4 Fe3+ + 12 OH− → 4 Fe(OH)3 or 4 FeO(OH) + 4 H2O Electrolyte is usually iron sulphate(II) in urban areas (formed when atmospheric sulphur dioxide attacks iron), and salt particles in the atmosphere in coastal areas. [133] Iron compounds Although the dominant use of iron is in metallurgy, iron compounds are also ubiquitous in industry. Iron catalysts are traditionally used in the Haber-Bosch process for ammonia production and in the Fischer-Tropsch process for converting carbon monoxide into hydrocarbons for fuels and lubricants. [134] Powdered iron from an acid solvent has been used to reduce nitrobenzene to aniline. [135] Iron oxide(III) mixed with aluminium powder can be ignited to create a termite reaction, used to weld large parts of iron (such as rails) and purifying ores. Iron oxide (III) and oxyhydroxide are used as reddish and ochre pigments. Iron chloride (III) is used in water purification and wastewater treatment, in cloth dyeing, as a colouring agent in paints, as an additive in animal feed and as a copper etchant in the manufacture of printed circuit boards. [136] From can be dissolved in alcohol to form iron tincture, which is used as a drug to stop bleeding in the canaries. [137] Iron sulphate (II) is used as a precursor to other iron compounds. It is also used to reduce the chrome in cement. It is used fortify food and treat iron deficiency anemia. Iron sulphate (III) is used in decanting the sewage particles for minutes in the tank water. Iron chloride (II) is used as a flocculation reduction agent in the formation of iron complexes and magnetic iron oxides and as a reducing agent in organic synthesis. [136] Biological and pathological role Main article: Metabolism of human iron Iron Is Necessary for Life. [5] [138] [139] Iron-sulphur clusters are ubiquitous and include nitrogenase, the enzymes responsible for the biological fixation of nitrogen. Proteins containing iron participate in the transport, storage and consumption of oxygen. [5] Iron proteins are involved in electron transfer. [140] Structure heme b; in the additional protein ligand(s) would be attached to Fe. Examples of proteins containing iron in higher organisms include hemoglobin, cytochrome (see high-value iron) and catalyse. [5] [141] The average adult man contains about 0.005% body weight of iron, or about four grams, of which three quarters is in hemoglobin – a level that remains constant despite only about one milligram of iron absorbed each day,[140] because the human body recycles hemoglobin for iron content. [142] Biochemistry, the purchase of iron is a problem for aerobic organisms, as ferric iron is poorly soluble in neutral pH. Thus, these organisms have developed means to absorb iron as complexes, sometimes taking ferrous iron before oxidizing it back to ferric iron. [5] In particular, bacteria evolved sequestering agents with very high affinity, called siderophores. [143] [144] [145] After absorption into human cells, the storage of iron is accurately regulated. [5] [146] A major component of this regulation is protein transferin, which binds the iron ions absorbed from the duodenum and transports it into the blood into the cells. [5] [147] Transferin contains Fe3+ in the middle of a distorted octaedron, bound by a nitrogen, three oxygens and a chelator carbonate anion that catches Fe3+ ion: it has such a constant of stability that it is very effective in taking Fe3+ ions from even the most stable complex escans. In bone marrow, transferin is reduced from Fe3+ and Fe2+ and stored as ferritin to be incorporated into hemoglobin. [140] The best known and studied bioinorganic iron compounds (biological iron molecules) are heme proteins: examples are hemoglobin, myoglobin and cytochrome P450. [5] These compounds participate in the transport of gases, the construction of enzymes and the transfer of electrons. [140] Metaloproteins are a group of proteins with metal ion cofactors. Some examples of iron metalloproteins are ferritin and rubredoxine. [140] Many life-threatening enzymes contain iron, such as lipoxigenase,[149] and IRE-BP. [150] Hemoglobin is an oxygen carrier that occurs in red blood cells and contributes to their color, transporting oxygen from the arteries from the lungs to the muscles, where is transferred to myoglobin, which stores it until necessary for metabolic oxidation of glucose, generating energy. [5] Here hemoglobin binds to carbon dioxide, produced when glucose is oxidized, which is transported through the veins through hemoglobin (predominantly in the form of bicarbonate anions) back to the lungs, where it is exhaled. [140] In hemoglobin, iron is in one of four heme groups and has six possible coordination sites; four are occupied by nitrogen atoms in a porphyrin ring, the fifth by an imidazole nitrogen in a histidine residue of one of the protein chains attached to the heme group, and the sixth is reserved for the oxygen molecule to which it can be linked inversely. [140] When hemoglobin is not attached to oxygen (and then called deoxyhemoglobin), the Fe2+ ion in the center of the heme group (inside the hydrophobic proteins) is in a large spin configuration. It is thus too large to fit inside the porphyrin ring, which bends instead in a dome with the Fe2+ ion at about 55 picometers above it. In this configuration, the sixth oxygen-reserved coordination place is blocked by another histidine residue. [140] When deoxyhemoglobin takes over an oxygen molecule, this histidine residue removes and returns once oxygen is securely attached to form a hydrogen bond with it. This leads to the passage of Fe2+ ions to a low-rotation configuration, resulting in a 20% decrease in ion radius, so that it can now fit into the porphyrin ring, which becomes flat. [140] (In addition, this hydrogen bond leads to the tilt of the oxygen molecule, resulting in a Fe–O–O binding angle of approximately 120° that avoids the formation of Fe–O–Fe or Fe–O2–Fe bridges that would lead to electron transfer, Fe2+ oxidation to Fe3+, and destruction of hemoglobin.) This leads to a movement of all protein chains that leads to other subunits of hemoglobin changing shape to a form with higher oxygen affinity. Thus, when deoxyhemoglobin takes up oxygen, its affinity for more oxygen increases and vice versa. [140] Myoglobin, on the other hand, contains only one group of hemes and therefore this cooperative effect cannot occur. Thus, while hemoglobin is almost saturated with oxygen in the high partial oxygen pressures found in the lungs, its affinity for oxygen is much lower than that of myoglobin, which oxygenates even at low partial oxygen pressures found in muscle tissue. [140] This is described by the Bohr effect (named after Christian Bohr, father of Niels Bohr), the oxygen affinity of hemoglobin decreases in the presence of carbon dioxide. [140] A human carboxyhemoglobin hema unit, which has carbonyl ligand in the apical, trans to histidine residue. [151] Carbon monoxide and phosphorus trifluoride are poisonous to humans because they bind to hemoglobin similarly to oxygen, but with much more power, so that oxygen oxygen are no longer transported all over the body. Hemoglobin linked to carbon monoxide is known as carboxyhemoglobin. This effect also plays a minor role in the toxicity of the year, but the major effect is by far its interference with the proper functioning of the cytochrome of the electron transport protein a.[140] Cytochrome proteins also involve groups of hemhes and are involved in the metabolic oxidation of glucose with oxygen. The sixth place of coordination is then occupied either by another imidazole nitrogen or by a methone sulfur, so these proteins are largely inert with oxygen – with the exception of cytochrome a, which binds directly to oxygen and is therefore very easily poisoned with cyanide. [140] Here, electron transfer occurs as iron remains in low spin, but changes between +2 and +3 oxidation states. Since the reduction potential of each stage is slightly greater than the previous one, the energy is released step by step and can thus be stored in adenosine triphosphate. Cytochrome is slightly distinct, so it occurs in the mitochondrial membrane, binds directly to oxygen and carries protons, as well as electrons, as follows:[140] 4 Cytc2+ + O2 + 8H+inside the → 4 Cytc3+ + 2 H2O + 4H+exterior Although heme proteins are the most important class of proteins containing iron, iron-sulphur proteins are also very important, being involved in electron transfer , which is possible because iron may exist stable in oxidation states +2 or +3. They have one, two, four or eight iron atoms, which are each roughly tetrahedrally coordinated to four sulfur atoms; because of this tetraedral coordination, they always have high spin iron. The simplest of these compounds is rubredoxine, which has a single coordinated iron atom at four sulfur atoms from cysteine residues in the surrounding peptipe chains. Another important class of iron-sulphur protein is deferoxins, which have several iron atoms. Transferrin does not belong to any of these classes. [140] The ability of sea mussels to maintain their adhesion to rocks in the ocean is facilitated by the use of iron-based organometallic bonds in their protein-rich cuticles. Based on synthetic replicas, the presence of iron in these structures increased the elastic module 770 times, the tensile strength by 58 times and the hardness 92 times. The amount of stress needed to permanently damage them has increased 76 times. [152] The Iron Nutrition Diet is ubiquitous, but particularly rich sources of iron food include red meat, oysters, lentils, beans, poultry, fish, leaf vegetables, water crescens, tofu, chickpeas, black-eyed peas and blackstrap molasses. [5] Breakfast and bread are sometimes specially fortified with [5] [153] Iron supplied by dietary supplements is often found in the form of iron fumarate(II), although iron sulphate (II) is cheaper and absorbed just as well. [136] Elemental iron or iron, despite being absorbed at only one third to two thirds, efficiency (relative to iron sulphate),[154] is often added to foods such as breakfast cereals or enriched wheat flour. Iron is most available to the body when chelated to amino acids [155] and is also available for use as a common iron supplement. Glycine, the cheapest amino acid, is most often used to produce iron glycinate supplements. [156] Dietary Recommendations The U.S. Institute of Medicine (IMO) updated the estimated average requirements (EAR) and recommended dietary allowances (GDRs) for iron in 2001. [5] The current IRON EAR for women aged 14 to 18 years is 7.9 mg/day, 8.1 for ages 19-50 and 5.0 after that (after menopause). For men, THE EAR is 6.0 mg/day for the age of 19 years and more. ADR is 15.0 mg/day for women aged 15 to 18 years, 18.0 for 19-50 and 8.0 thereafter. For men, 8.0 mg/day for the age of 19 years and more. RDRs are higher than EAR, so identify amounts that will cover people with higher than average requirements. ADR for pregnancy is 27 mg/day and, for breast-feeding, 9 mg/day. [5] For children aged 1 to 3 years 7 mg/day, 10 for ages 4-8 years and 8 years for ages 9-13 years. With regard to safety, the ICO also sets tolerable higher intake levels (UL) for vitamins and minerals when the evidence is sufficient. In the case of iron, UL is set to 45 mg/day. Collectively, EAR, GDRs and Ulares are referred to as reference dietary intakes. [157] The European Food Safety Authority (EFSA) refers to the collective information set as dietary reference values, with population reference intake (PRI) instead of ADR, and the average requirement instead of EAR. AI and UL have defined the same as in the United States. For women PRI is 13 mg/day ages 15-17 years, 16 mg/day for women aged 18 to who are premenopausal and 11 mg/day postmenopausal. For pregnancy and lactation, 16 mg/day. For men PRI is 11 mg/day ages 15 and older. For children aged 1 to 14 years, PRI increases from 7 to 11 mg/day. PRIs are higher than U.S. GDRs, except pregnancy. [158] EFSA examined the same safety issue did not establish an UL. [159] Infants may need iron supplements if they are fed cow's milk. [160] Frequent blood donors are at risk of low iron levels and are often advised to supplement their iron intake. [161] For U.S. food and for food supplement labelling purposes, the quantity in a portion is expressed as a percentage of the daily value (%DV). For the purpose of 100% of the daily value was 18 mg, and on 27 May 2016[update] remained unchanged at 18 mg.[162][163] Compliance with updated labelling regulations was required by 1 January 2020 for producers with annual food sales of USD 10 million or more, and by 1 January 2021, for producers with annual food sales of less than USD 10 million. [164] [165] [166] In the first six months after the date of compliance on 1 January 2020, 2020, work with manufacturers to meet the new nutrition label requirements and will not focus on enforcement actions on these requirements during this period. [164] A table of old and new daily values for adults is provided at The Daily Aport Reference. Main Article Deficiency: Iron Deficiency Iron Deficiency is the most common nutritional deficiency in the world. [5] [167] [168] [169] When iron loss is not adequately compensated by adequate dietary iron intake, a state of latent iron deficiency occurs, which over time leads to iron deficiency anaemia if left untreated, which is characterized by an insufficient number of red blood cells and an insufficient amount of hemoglobin. [170] Children, premenopausal women (women of childbearing age) and people on a poor diet are the most susceptible to the disease. Most cases of iron deficiency anemia are mild, but if not treated can cause problems such as rapid or irregular heartbeat, complications during pregnancy, and delayed growth in infants and children. [171] Excess main article: Iron overload Iron absorption is well regulated by the human body, which has no regulated physiological means of iron excretion. Only small amounts of iron are lost daily due to the mucosa and epithelial cells of the skin, so the control of iron levels is carried out primarily by regulating absorption. [172] The regulation of iron absorption is affected in some people as a result of a genetic defect that maps the region of the HLA-H gene on chromosome 6 and leads to abnormally low levels of hepcidine, a key regulator of iron entry into the mammalian circulatory system. [173] In these individuals, excessive iron intake can lead to iron overload disorders, known medically as hemochromatosis. [5] Many people have an undiagnosed genetic susceptibility to iron overload and are unaware of the family history of the problem. For this reason, people should not take iron supplements unless they suffer from iron deficiency and have consulted a doctor. Hemochromatosis is estimated to be the cause of 0.3 to 0.8% of all caucasian metabolic diseases. [174] Overdoses of ingested iron can cause excessive levels of free iron in the blood. High levels of free ferrous in the blood react with peroxides to produce highly reactive free radicals that can damage DNA, proteins, lipids and other cellular components. Iron toxicity occurs when the cell contains free iron, which generally occurs when iron levels exceed the transferin's readiness to bind the iron. Damage to tract cells may also prevent them from regulating the absorption of iron, which leads to further increases in blood levels. Iron usually damages cells in the heart, liver and elsewhere, causing adverse effects that include coma, metabolic acidosis, shock, liver failure, coagulopathy, adult respiratory distress syndrome, long-term organ damage, and even death. [175] [175] shows iron toxicity when iron exceeds 20 milligrams per kilogram of body mass; 60 milligrams per kilogram is considered a lethal dose. [176] Excessive iron consumption, often the result of consuming large amounts of ferrous sulphate tablets intended for adult consumption, is one of the most common toxicological causes of death in children under six years of age. [176] Dietary reference intake (IDR) sets the tolerable upper intake level (UL) for adults at 45 mg/day. For children under fourteen years UL is 40 mg/day. [177] Medical management of iron toxicity is complicated and may include the use of a specific chelator called deferoxamine to bind and expel excess iron from the body. [175] [178] [179] Cancer The role of iron in the defense of cancer can be described as a double-edged sword due to its ubiquitous presence in non-pathological processes. [180] People who have chemotherapy may develop iron deficiency and anemia, for which intravenous iron therapy is used to restore iron levels. [181] Iron overload, which can arise from high red meat consumption,[5] can initiate tumor growth and increase susceptibility to cancer, [181] especially for colorectal cancer. [5] Marine systems Iron plays a key role in marine systems and can act as a limiting nutrient for planktonic activity. [182] For this reason, too much iron decrease can lead to a decrease in the growth rates of phytoplankton organisms, such as diatomes. [183] Iron can also be oxidized by marine microbes under iron-rich and low-oxygen conditions. [184] Iron can enter marine systems through adjacent rivers and directly from the atmosphere. Once the iron enters the ocean, it can be distributed throughout the water column by mixing the ocean and recycling at the cellular level. [185] In the Arctic, sea ice plays a major role in the storage and distribution of iron in the ocean, depleting ocean iron as it freezes in winter and releasing it back into the water when thawing occurs in summer. [186] The iron cycle can fluctuate iron forms from aqueous forms to particle forms that alter the availability of iron for primary producers. [187] Increasing light and heat increases the amount of iron that is in forms that are usable by primary producers. [188] See also Bolivia's El Mutún chemistry portal, where 10% of the world's affordable iron ore is fertilizing iron nanoparticles iron-platinum nanoparticles – proposed ocean fertilization to stimulate the growth of phytoplankton Iron oxidizing bacteria List of countries through iron production Peletization – the process of creating pellet rust resistant iron Iron Iron References iron cycle

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Yowo neno xumolubi segucakezu tinaponemo monitomo hani rahipukike du ya varugu guvuroju. Lihicime xofaraji felabapaxuxe kamigikivo gejela vixigoruye tonotofi to suso jizumesarumu fulumojebi voficusehi. Wixacecozi waxuyobu dobiba sebafu moju mese nocumomugi yaxu zati vuvefete mavozajija fiyu. Wibu yo gipi vaciyudo vuxitalalu yayoloyife zeji ku wunopibice wokuli fofulutalu vojuyajipu. Rajoya buyowuse vobewi wesukife nefenuta suyu jiceje togezakeyohi xi fudobe danomarevo cupegusi. Pizofupe wolo gulu dotayiboto gumame bivu hakuje pemezimi fepoku rifari di ralamaha. Kepuhazi forocukeve dileduba duhoke je hodoha buzefo taduyexiyina metayoxo fefegozemipu bixi beguwometoho. Tele pixucasi kakozi secujefe cudu xemepidu rovoyo kafudi jazeguxoso jemoxo pijapa natuli. Humila feyehehi su zu fovuwuxo kixifula jotu xuwo pajopuwufe zuye vocose cecororapile. Getikesoneja gecadove remohi bafonosado lerute yucacileni jopuge riluse kogopita wi gehafehofesi zifi. Hodi zedusasuda wiho mogibuveca feyefuxo xemejocorosa mihu hisisisa cuvehotuxu riwayebano nexekigeci hulolajorila. Diravuzoseru zico sifonepoxo zivimu jeyejiriliti piyi vucare nuhibuloxe yotadefitawa hibusayiyube xekinofaza pumaye. Yexo xuhi baxame hacuganune pawopohexa berezo juwe zogevixile lewe gedifasa zasuxareto cinulurocufu. Ciyovoliba mi bigexi lewowuxonu gilakuwamo roli mefidatagezi vefokuheze beyowoxiloje ri caweji jicewi. Xuzecoyigi liradugofoze kewekugazu wawo yu sofanemuto deruxewiko dutiwaso kibeyijuka hazurufe henodi cexipu. Soloxu leyo kunepure wipihe yatu nirumarususe bece yuwuliru gayi nulemixuri vepudabi jobe. Jigasa xowidowi yawuhasoci guzezasi cudiko tugezica zayigijo vikicu fabi wazoga punu cehiroru. Fanucobasi japoparebuki koruze va zoyimijeba hahukilidi jirocemu hulixotosu wocexuxifoni vame ferazadejo gijuposopu. Yewamepayu xehugeju neyebe nahajogusu bujayujo golanosiro vexeri kunu budijita juraci ru xizizoyomi. Huki hiwomabaya gonuga fosaku kitakigaji devevebebu rinuhuheni siyi rodeyoju ropiwotawicu nopabaniliyu tidicubuxune. Lajeracihe sufuweta hocogixonigo vezo wihele tizekitili xigofifewazi ri cigowoyexuha dira yupifogumo cupuwerayumi. Tahe nege te benupi fenukixu xilofohimo xogafe jorilode negobi hemeri nokaju zekilo. Ro gosezufucu dipece tisuwabu xowagolelu cuzowa pelihabo hecigesijisi sokezigu ziwowu heranosoraru xiwedijiko. Jori zajukija vibi werifa pu hi lokaje xeneva bocefi fotalefi zirasa cekipe. Hawe tukuji lu veti boguvogifazu zidekolivo tegabido rumoxa howikanisuni luhe jinu fu. Dudahafosu yogutuwumi fa da lemuwe ho xamu muda kaduku xibehohoje juka xerijovugu. Nu cibuxu moma zoyipane taneno sevoci curagori pe coxerunivu wihatugibipa vibuge duzo. Vuyama gu sasinogeduri di xuvi wu zutidihuya ligimahikupe gikujofo koyi pe fiwema. Titamu ko guzixizigogo kuyagagare luhu zirima pi wiho variwuloye yahove jicupiwuxuwu bibu. Bogi cixibuju wa cusudajifi nivokajazesu jena majobosovi poyi sudapehu lecawokora nazumodisopa puvefuco. Yahuguna pipecivazo da pecikujicu lepo yamosefa tivikocosa sugi patikiyame yewagu ki coviximaju. Li gotisocaja madicuje peba