CARBON

Carbon (from Latin: carbo "coal") is a chemical element with the symbol C and atomic number 6. It is nonmetallic and tetravalent—making four electrons available to form covalent chemical bonds. It belongs to group 14 of the periodic table.[14] Carbon makes up only about 0.025 percent of Earth's crust.[15] Three isotopes occur naturally, 12C and 13C being stable, while 14C is a radionuclide, decaying with a half-life of about 5,730 years.[16] Carbon is one of the few elements known since antiquity.[17]

Carbon is the 15th most abundant element in the Earth's crust, and the fourth most abundant element in the universe by mass after hydrogen, helium, and oxygen. Carbon's abundance, its unique diversity of organic compounds, and its unusual ability to form polymers at the temperatures commonly encountered on Earth enables this element to serve as a common element of all known life. It is the second most abundant element in the human body by mass (about 18.5%) after oxygen.[18]

The atoms of carbon can bond together in diverse ways, resulting in various allotropes of carbon. Well-known allotropes include graphite, diamond, amorphous carbon and fullerenes. The physical properties of carbon vary widely with the allotropic form. For example, graphite is opaque and black while diamond is highly transparent. Graphite is soft enough to form a streak on paper (hence its name, from the Greek verb "γράφειν" which means "to write"), while diamond is the hardest naturally occurring material known. Graphite is a good electrical conductor while diamond has a low electrical conductivity. Under normal conditions, diamond, carbon nanotubes, and graphene have the highest thermal conductivities of all known materials. All carbon allotropes are solids under normal conditions, with graphite being the most thermodynamically stable form at standard temperature and pressure. They are chemically resistant and require high temperature to react even with oxygen.

The most common oxidation state of carbon in inorganic compounds is +4, while +2 is found in carbon monoxide and transition metal carbonyl complexes. The largest sources of inorganic carbon are limestones, dolomites and carbon dioxide, but significant quantities occur in organic deposits of coal, peat, oil, and methane clathrates. Carbon forms a vast number of compounds, more than any other element, with almost ten million compounds described to date,[19] and yet that number is but a fraction of the number of theoretically possible compounds under standard conditions. For this reason, carbon has often been referred to as the "king of the elements".

The allotropes of carbon include graphite, one of the softest known substances, and diamond, the hardest naturally occurring substance. It bonds readily with other small atoms, including other carbon atoms, and is capable of forming multiple stable covalent bonds with suitable multivalent atoms. Carbon is known to form almost ten million compounds, a large majority of all chemical compounds.[19] Carbon also has the highest sublimation point of all elements. At atmospheric pressure it has no melting point, as its triple point is at 10.8 ± 0.2 megapascals (106.6 ± 2.0 atm; 1,566 ± 29 psi) and 4,600 ± 300 K (4,330 ± 300 °C; 7,820 ± 540 °F),[3][4] so it sublimes at about 3,900 K (3,630 °C; 6,560 °F).[22][23] Graphite is much more reactive than diamond at standard conditions, despite being more thermodynamically stable, as its delocalised pi system is much more vulnerable to attack. For example, graphite can be oxidised by hot concentrated nitric acid at standard conditions to mellitic acid, $C_6(CO_2H)_6$, which preserves the hexagonal units of graphite while breaking up the larger structure.[24]

Carbon sublimes in a carbon arc, which has a temperature of about 5800 K (5,530 °C or 9,980 °F). Thus, irrespective of its allotropic form, carbon remains solid at higher temperatures than the highest-melting-point metals such as tungsten or rhenium. Although thermodynamically prone to oxidation, carbon resists oxidation more effectively than elements such as iron and copper, which are weaker reducing agents at room temperature.

Carbon is the sixth element, with a ground-state electron configuration of 1s22s22p2, of which the four outer electrons are valence electrons. Its first four ionisation energies, 1086.5, 2352.6, 4620.5 and 6222.7 kJ/mol, are much higher than those of the heavier group-14 elements. The electronegativity of carbon is 2.5, significantly higher than the heavier group-14 elements (1.8–1.9), but close to most of the nearby nonmetals, as well as some of the second- and third-row transition metals. Carbon's covalent radii are normally taken as 77.2 pm (C−C), 66.7 pm (C=C) and 60.3 pm (C≡C), although these may vary depending on coordination number and what the carbon is bonded to. In general, covalent radius decreases with lower coordination number and higher bond order.[25]