

Sodium

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Sodium is a chemical element with symbol **Na** (from Latin *natrium*) and atomic number 11. It is a soft, silvery-white, highly reactive metal. Sodium is an alkali metal, being in group 1 of the periodic table, because it has a single electron in its outer shell that it readily donates, creating a positively charged atom—the Na^+ cation. Its only stable isotope is ^{23}Na . The free metal does not occur in nature, but must be prepared from compounds. Sodium is the sixth most abundant element in the Earth's crust, and exists in numerous minerals such as feldspars, sodalite and rock salt (NaCl). Many salts of sodium are highly water-soluble: sodium ions have been leached by the action of water from the Earth's minerals over eons, and thus sodium and chlorine are the most common dissolved elements by weight in the oceans.

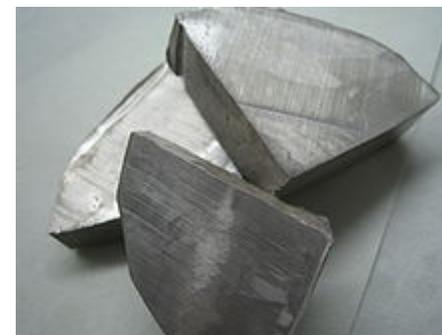
Sodium was first isolated by Humphry Davy in 1807 by the electrolysis of sodium hydroxide. Among many other useful sodium compounds, sodium hydroxide (lye) is used in soap manufacture, and sodium chloride (edible salt) is a de-icing agent and a nutrient for animals including humans.

Sodium is an essential element for all animals and some plants. Sodium ions are the major cation in the extracellular fluid (ECF) and as such are the major contributor to the ECF osmotic pressure and ECF compartment volume. Loss of water from the ECF compartment increases the sodium concentration, a condition called hypernatremia. Isotonic loss of water and sodium from the ECF compartment decreases the size of that compartment in a condition called ECF hypovolemia.

By means of the sodium-potassium pump, living human cells pump three sodium ions out of the cell in exchange for two potassium ions pumped in; comparing ion concentrations across the cell membrane, inside to outside, potassium measures about 40:1, and sodium, about 1:10. In nerve cells, the electrical charge across the cell membrane enables transmission of the nerve impulse—an action potential—when the charge is dissipated; sodium plays a key role in that activity.

Characteristics

Sodium, $_{11}\text{Na}$



Spectral lines of sodium

General properties

Name, symbol	sodium, Na
Pronunciation	/ˈsoʊdiəm/ <i>SOH-dee-əm</i>
Appearance	silvery white metallic

Sodium in the periodic table

Atomic number (<i>Z</i>)	11
Group, block	group 1 (alkali metals), s-block
Period	period 3
Element category	☐ alkali metal
Standard atomic weight (\pm) (<i>A</i> _r)	22.98976928(2) ^[1]
Electron configuration	[Ne] 3s ¹
per shell	2, 8, 1

Physical



Emission spectrum for sodium, showing the D line.

Sodium at standard temperature and pressure is a soft silvery metal that combines with oxygen in air and forms grayish white sodium oxide unless immersed in oil or inert gas, which are the conditions it is usually stored in. Sodium metal can be easily cut with a knife and is a good conductor of electricity and heat because it has only one electron in its valence shell, resulting in weak metallic

bonding and free electrons, which carry energy. Due to having low atomic weight and large atomic radius, sodium is third-least dense of all elemental metals and is one of only three metals that can float on water, the other two being lithium and potassium.^[4] The melting (98 °C) and boiling (883 °C) points of sodium are lower than those of lithium but higher than those of the heavier alkali metals potassium, rubidium, and caesium, following periodic trends down the group.^[5] These properties change dramatically at elevated pressures: at 1.5 Mbar, the color changes from silvery metallic to black; at 1.9 Mbar the material becomes transparent with a red color; and at 3 Mbar, sodium is a clear and transparent solid. All of these high-pressure allotropes are insulators and electrides.^[6]

In a flame test, sodium and its compounds glow yellow^[7] because the excited 3s electrons of sodium emit a photon when they fall from 3p to 3s; the wavelength of this photon corresponds to the D line at 589.3 nm. Spin-orbit interactions involving the electron in the 3p orbital split the D line into two; hyperfine structures involving both orbitals cause many more lines.^[8]

Isotopes

Twenty isotopes of sodium are known, but only ²³Na is stable. ²³Na is created in the carbon-burning process in stars by fusing two carbon atoms together; this requires temperatures above 600 megakelvins and a star of at least three solar masses.^[9] Two radioactive, cosmogenic isotopes are the byproduct of cosmic ray spallation: ²²Na has a half-life of 2.6 years and ²⁴Na, a half-life of 15 hours; all other isotopes have a half-life of less than one minute.^[10] Two nuclear isomers have been

Physical properties

Phase	solid
Melting point	370.944 K (97.794 °C, 208.029 °F)
Boiling point	1156.090 K (882.940 °C, 1621.292 °F)
Density near r.t.	0.968 g/cm ³
when liquid, at m.p.	0.927 g/cm ³
Critical point	2573 K, 35 MPa (<i>extrapolated</i>)
Heat of fusion	2.60 kJ/mol
Heat of vaporization	97.42 kJ/mol
Molar heat capacity	28.230 J/(mol·K)

Vapor pressure

P (Pa)	1	10	100	1 k	10 k	100 k
at T (K)	554	617	697	802	946	1153

Atomic properties

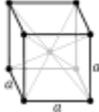
Oxidation states	+1, −1 (a strongly basic oxide)
Electronegativity	Pauling scale: 0.93
Ionization energies	1st: 495.8 kJ/mol 2nd: 4562 kJ/mol 3rd: 6910.3 kJ/mol (more)
Atomic radius	empirical: 186 pm
Covalent radius	166±9 pm
Van der Waals radius	227 pm

Miscellanea

discovered, the longer-lived one being ^{24m}Na with a half-life of around 20.2 milliseconds. Acute neutron radiation, as from a nuclear criticality accident, converts some of the stable ²³Na in human blood to ²⁴Na; the neutron radiation dosage of a victim can be calculated by measuring the concentration of ²⁴Na relative to ²³Na.^[11]

External links

- Wikipedia: Sadium (<https://en.wikipedia.org/wiki/Sodium>)

Crystal structure	body-centered cubic (bcc) 
Speed of sound thin rod	3200 m/s (at 20 °C)
Thermal expansion	71 μm/(m·K) (at 25 °C)
Thermal conductivity	142 W/(m·K)
Electrical resistivity	47.7 nΩ·m (at 20 °C)
Magnetic ordering	paramagnetic ^[2]
Young's modulus	10 GPa
Shear modulus	3.3 GPa
Bulk modulus	6.3 GPa
Mohs hardness	0.5
Brinell hardness	0.69 MPa
CAS Number	7440-23-5

History

Discovery and first isolation Humphry Davy (1807)

Most stable isotopes of sodium

iso	NA	half-life	DM	DE (MeV)	DP
22Na	trace	2.602 y	β ⁺ →γ	0.5454	²² Ne*
				1.27453(2) ^[3]	²² Ne
			ε→γ	-	²² Ne*
				1.27453(2)	²² Ne
				1.8200	²² Ne
23Na	100%	is stable with 12 neutrons			