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**Sodium**

From Wikipedia, the free encyclopedia

[Jump to navigation](https://en.wikipedia.org/wiki/Sodium#mw-head) [Jump to search](https://en.wikipedia.org/wiki/Sodium#p-search)

This article is about the chemical element. For the nutrient commonly called sodium, see [salt](https://en.wikipedia.org/wiki/Salt). For other uses, see [sodium (disambiguation)](https://en.wikipedia.org/wiki/Sodium_(disambiguation)).

"Natrium" redirects here. For other uses, see [Natrium (disambiguation)](https://en.wikipedia.org/wiki/Natrium_(disambiguation)).

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| --- | --- |
| Sodium,  11Na | |
| [Na (Sodium).jpg](https://en.wikipedia.org/wiki/File:Na_(Sodium).jpg) | |
| **General properties** | |
| **Appearance** | silvery white metallic |
| [**Standard atomic weight**](https://en.wikipedia.org/wiki/Standard_atomic_weight) **(*A*r, standard)** | 22.98976928(2)[[1]](https://en.wikipedia.org/wiki/Sodium#cite_note-CIAAW2016-1) |
| **Sodium in the** [**periodic table**](https://en.wikipedia.org/wiki/Periodic_table) | |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 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[Neon](https://en.wikipedia.org/wiki/Neon) | | Sodium | [Magnesium](https://en.wikipedia.org/wiki/Magnesium) |  | | | | | | | | | | | | | | | | | | | | | | | | [Aluminium](https://en.wikipedia.org/wiki/Aluminium) | [Silicon](https://en.wikipedia.org/wiki/Silicon) | [Phosphorus](https://en.wikipedia.org/wiki/Phosphorus) | [Sulfur](https://en.wikipedia.org/wiki/Sulfur) | [Chlorine](https://en.wikipedia.org/wiki/Chlorine) | [Argon](https://en.wikipedia.org/wiki/Argon) | | [Potassium](https://en.wikipedia.org/wiki/Potassium) | [Calcium](https://en.wikipedia.org/wiki/Calcium) | [Scandium](https://en.wikipedia.org/wiki/Scandium) |  | | | | | | | | | | | | | | [Titanium](https://en.wikipedia.org/wiki/Titanium) | [Vanadium](https://en.wikipedia.org/wiki/Vanadium) | [Chromium](https://en.wikipedia.org/wiki/Chromium) | [Manganese](https://en.wikipedia.org/wiki/Manganese) | [Iron](https://en.wikipedia.org/wiki/Iron) | [Cobalt](https://en.wikipedia.org/wiki/Cobalt) | [Nickel](https://en.wikipedia.org/wiki/Nickel) | [Copper](https://en.wikipedia.org/wiki/Copper) | [Zinc](https://en.wikipedia.org/wiki/Zinc) | [Gallium](https://en.wikipedia.org/wiki/Gallium) | [Germanium](https://en.wikipedia.org/wiki/Germanium) | [Arsenic](https://en.wikipedia.org/wiki/Arsenic) | [Selenium](https://en.wikipedia.org/wiki/Selenium) | [Bromine](https://en.wikipedia.org/wiki/Bromine) | [Krypton](https://en.wikipedia.org/wiki/Krypton) | | [Rubidium](https://en.wikipedia.org/wiki/Rubidium) | [Strontium](https://en.wikipedia.org/wiki/Strontium) | [Yttrium](https://en.wikipedia.org/wiki/Yttrium) |  |  | | | | | | | | | | | | | [Zirconium](https://en.wikipedia.org/wiki/Zirconium) | [Niobium](https://en.wikipedia.org/wiki/Niobium) | [Molybdenum](https://en.wikipedia.org/wiki/Molybdenum) | [Technetium](https://en.wikipedia.org/wiki/Technetium) | [Ruthenium](https://en.wikipedia.org/wiki/Ruthenium) | [Rhodium](https://en.wikipedia.org/wiki/Rhodium) | [Palladium](https://en.wikipedia.org/wiki/Palladium) | [Silver](https://en.wikipedia.org/wiki/Silver) | [Cadmium](https://en.wikipedia.org/wiki/Cadmium) | [Indium](https://en.wikipedia.org/wiki/Indium) | [Tin](https://en.wikipedia.org/wiki/Tin) | [Antimony](https://en.wikipedia.org/wiki/Antimony) | [Tellurium](https://en.wikipedia.org/wiki/Tellurium) | [Iodine](https://en.wikipedia.org/wiki/Iodine) | [Xenon](https://en.wikipedia.org/wiki/Xenon) | | [Caesium](https://en.wikipedia.org/wiki/Caesium) | [Barium](https://en.wikipedia.org/wiki/Barium) | [Lanthanum](https://en.wikipedia.org/wiki/Lanthanum) | [Cerium](https://en.wikipedia.org/wiki/Cerium) | [Praseodymium](https://en.wikipedia.org/wiki/Praseodymium) | [Neodymium](https://en.wikipedia.org/wiki/Neodymium) | [Promethium](https://en.wikipedia.org/wiki/Promethium) | [Samarium](https://en.wikipedia.org/wiki/Samarium) | [Europium](https://en.wikipedia.org/wiki/Europium) | [Gadolinium](https://en.wikipedia.org/wiki/Gadolinium) | [Terbium](https://en.wikipedia.org/wiki/Terbium) | [Dysprosium](https://en.wikipedia.org/wiki/Dysprosium) | [Holmium](https://en.wikipedia.org/wiki/Holmium) | [Erbium](https://en.wikipedia.org/wiki/Erbium) | [Thulium](https://en.wikipedia.org/wiki/Thulium) | [Ytterbium](https://en.wikipedia.org/wiki/Ytterbium) | [Lutetium](https://en.wikipedia.org/wiki/Lutetium) | [Hafnium](https://en.wikipedia.org/wiki/Hafnium) | [Tantalum](https://en.wikipedia.org/wiki/Tantalum) | [Tungsten](https://en.wikipedia.org/wiki/Tungsten) | [Rhenium](https://en.wikipedia.org/wiki/Rhenium) | [Osmium](https://en.wikipedia.org/wiki/Osmium) | [Iridium](https://en.wikipedia.org/wiki/Iridium) | [Platinum](https://en.wikipedia.org/wiki/Platinum) | [Gold](https://en.wikipedia.org/wiki/Gold) | [Mercury (element)](https://en.wikipedia.org/wiki/Mercury_(element)) | [Thallium](https://en.wikipedia.org/wiki/Thallium) | [Lead](https://en.wikipedia.org/wiki/Lead) | [Bismuth](https://en.wikipedia.org/wiki/Bismuth) | [Polonium](https://en.wikipedia.org/wiki/Polonium) | [Astatine](https://en.wikipedia.org/wiki/Astatine) | [Radon](https://en.wikipedia.org/wiki/Radon) | | [Francium](https://en.wikipedia.org/wiki/Francium) | [Radium](https://en.wikipedia.org/wiki/Radium) | [Actinium](https://en.wikipedia.org/wiki/Actinium) | [Thorium](https://en.wikipedia.org/wiki/Thorium) | [Protactinium](https://en.wikipedia.org/wiki/Protactinium) | [Uranium](https://en.wikipedia.org/wiki/Uranium) | [Neptunium](https://en.wikipedia.org/wiki/Neptunium) | [Plutonium](https://en.wikipedia.org/wiki/Plutonium) | [Americium](https://en.wikipedia.org/wiki/Americium) | [Curium](https://en.wikipedia.org/wiki/Curium) | [Berkelium](https://en.wikipedia.org/wiki/Berkelium) | [Californium](https://en.wikipedia.org/wiki/Californium) | [Einsteinium](https://en.wikipedia.org/wiki/Einsteinium) | [Fermium](https://en.wikipedia.org/wiki/Fermium) | [Mendelevium](https://en.wikipedia.org/wiki/Mendelevium) | [Nobelium](https://en.wikipedia.org/wiki/Nobelium) | [Lawrencium](https://en.wikipedia.org/wiki/Lawrencium) | [Rutherfordium](https://en.wikipedia.org/wiki/Rutherfordium) | [Dubnium](https://en.wikipedia.org/wiki/Dubnium) | [Seaborgium](https://en.wikipedia.org/wiki/Seaborgium) | [Bohrium](https://en.wikipedia.org/wiki/Bohrium) | [Hassium](https://en.wikipedia.org/wiki/Hassium) | [Meitnerium](https://en.wikipedia.org/wiki/Meitnerium) | [Darmstadtium](https://en.wikipedia.org/wiki/Darmstadtium) | [Roentgenium](https://en.wikipedia.org/wiki/Roentgenium) | [Copernicium](https://en.wikipedia.org/wiki/Copernicium) | [Nihonium](https://en.wikipedia.org/wiki/Nihonium) | [Flerovium](https://en.wikipedia.org/wiki/Flerovium) | [Moscovium](https://en.wikipedia.org/wiki/Moscovium) | [Livermorium](https://en.wikipedia.org/wiki/Livermorium) | [Tennessine](https://en.wikipedia.org/wiki/Tennessine) | [Oganesson](https://en.wikipedia.org/wiki/Oganesson) | | [Li](https://en.wikipedia.org/wiki/Lithium) ↑ **Na** ↓ [K](https://en.wikipedia.org/wiki/Potassium) | | [neon](https://en.wikipedia.org/wiki/Neon) ← **sodium** → [magnesium](https://en.wikipedia.org/wiki/Magnesium) | | | | |
| [**Atomic number**](https://en.wikipedia.org/wiki/Atomic_number)(*Z*) | 11 |
| [**Group**](https://en.wikipedia.org/wiki/Group_(periodic_table)) | [group 1 (alkali metals)](https://en.wikipedia.org/wiki/Alkali_metal) |
| [**Period**](https://en.wikipedia.org/wiki/Period_(periodic_table)) | [period 3](https://en.wikipedia.org/wiki/Period_(periodic_table)#Period_3) |
| [**Block**](https://en.wikipedia.org/wiki/Block_(periodic_table)) | [s-block](https://en.wikipedia.org/wiki/S-block) |
| [**Element category**](https://en.wikipedia.org/wiki/Names_for_sets_of_chemical_elements#Category) | [alkali metal](https://en.wikipedia.org/wiki/Alkali_metal) |
| [**Electron configuration**](https://en.wikipedia.org/wiki/Electron_configuration) | [[Ne](https://en.wikipedia.org/wiki/Neon)] 3s1 |
| Electrons per shell | 2, 8, 1 |
| **Physical properties** | |
| [**Phase**](https://en.wikipedia.org/wiki/Phase_(matter)) **at**[**STP**](https://en.wikipedia.org/wiki/Standard_conditions_for_temperature_and_pressure) | [solid](https://en.wikipedia.org/wiki/Solid) |
| [**Melting point**](https://en.wikipedia.org/wiki/Melting_point) | 370.944 [K](https://en.wikipedia.org/wiki/Kelvin) ​(97.794 °C, ​208.029 °F) |
| [**Boiling point**](https://en.wikipedia.org/wiki/Boiling_point) | 1156.090 K ​(882.940 °C, ​1621.292 °F) |
| [**Density**](https://en.wikipedia.org/wiki/Density)(near r.t.) | 0.968 g/cm3 |
| when liquid (at m.p.) | 0.927 g/cm3 |
| [**Critical point**](https://en.wikipedia.org/wiki/Critical_point_(thermodynamics)) | 2573 K, 35 MPa *(extrapolated)* |
| [**Heat of fusion**](https://en.wikipedia.org/wiki/Enthalpy_of_fusion) | 2.60 [kJ/mol](https://en.wikipedia.org/wiki/Kilojoule_per_mole) |
| [**Heat of vaporization**](https://en.wikipedia.org/wiki/Enthalpy_of_vaporization) | 97.42 kJ/mol |
| [**Molar heat capacity**](https://en.wikipedia.org/wiki/Molar_heat_capacity) | 28.230 J/(mol·K) |
| [**Vapor pressure**](https://en.wikipedia.org/wiki/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**](https://en.wikipedia.org/wiki/Oxidation_state) | −1, **+1** (a strongly [basic](https://en.wikipedia.org/wiki/Base_(chemistry)) oxide) |
| [**Electronegativity**](https://en.wikipedia.org/wiki/Electronegativity) | Pauling scale: 0.93 |
| [**Ionization energies**](https://en.wikipedia.org/wiki/Ionization_energy) | * 1st: 495.8 kJ/mol * 2nd: 4562 kJ/mol * 3rd: 6910.3 kJ/mol * ([more](https://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements#sodium)) |
| [**Atomic radius**](https://en.wikipedia.org/wiki/Atomic_radius) | empirical: 186 [pm](https://en.wikipedia.org/wiki/Picometre) |
| [**Covalent radius**](https://en.wikipedia.org/wiki/Covalent_radius) | 166±9 pm |
| [**Van der Waals radius**](https://en.wikipedia.org/wiki/Van_der_Waals_radius) | 227 pm |
| [Color lines in a spectral range](https://en.wikipedia.org/wiki/File:Sodium_spectrum_visible.png)  [**Spectral lines**](https://en.wikipedia.org/wiki/Spectral_line) **of sodium** | |
| **Other properties** | |
| [**Crystal structure**](https://en.wikipedia.org/wiki/Crystal_structure) | ​[body-centered cubic](https://en.wikipedia.org/wiki/Cubic_crystal_system) (bcc)  [Body-centered cubic crystal structure for sodium](https://en.wikipedia.org/wiki/File:Cubic-body-centered.svg) |
| [**Speed of sound**](https://en.wikipedia.org/wiki/Speed_of_sound)thin rod | 3200 m/s (at 20 °C) |
| [**Thermal expansion**](https://en.wikipedia.org/wiki/Coefficient_of_thermal_expansion) | 71 µm/(m·K) (at 25 °C) |
| [**Thermal conductivity**](https://en.wikipedia.org/wiki/Thermal_conductivity) | 142 W/(m·K) |
| [**Electrical resistivity**](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) | 47.7 nΩ·m (at 20 °C) |
| [**Magnetic ordering**](https://en.wikipedia.org/wiki/Magnetism) | [paramagnetic](https://en.wikipedia.org/wiki/Paramagnetism)[[2]](https://en.wikipedia.org/wiki/Sodium#cite_note-2) |
| [**Magnetic susceptibility**](https://en.wikipedia.org/wiki/Magnetic_susceptibility) | +16.0·10−6 cm3/mol (298 K)[[3]](https://en.wikipedia.org/wiki/Sodium#cite_note-3) |
| [**Young's modulus**](https://en.wikipedia.org/wiki/Young%27s_modulus) | 10 GPa |
| [**Shear modulus**](https://en.wikipedia.org/wiki/Shear_modulus) | 3.3 GPa |
| [**Bulk modulus**](https://en.wikipedia.org/wiki/Bulk_modulus) | 6.3 GPa |
| [**Mohs hardness**](https://en.wikipedia.org/wiki/Mohs_scale_of_mineral_hardness) | 0.5 |
| [**Brinell hardness**](https://en.wikipedia.org/wiki/Brinell_hardness_test) | 0.69 MPa |
| [**CAS Number**](https://en.wikipedia.org/wiki/CAS_Registry_Number) | 7440-23-5 |
| **History** | |
| [**Discovery**](https://en.wikipedia.org/wiki/Timeline_of_chemical_element_discoveries) **and first isolation** | [Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy) (1807) |
| **Main** [**isotopes of sodium**](https://en.wikipedia.org/wiki/Isotopes_of_sodium) | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | [**Iso­tope**](https://en.wikipedia.org/wiki/Isotope) | [**Abun­dance**](https://en.wikipedia.org/wiki/Natural_abundance) | [**Half-life**](https://en.wikipedia.org/wiki/Half-life) **(*t*1/2)** | [**Decay mode**](https://en.wikipedia.org/wiki/Radioactive_decay) | [**Pro­duct**](https://en.wikipedia.org/wiki/Decay_product) | | **22Na** | [trace](https://en.wikipedia.org/wiki/Trace_radioisotope) | 2.602 y | [β+](https://en.wikipedia.org/wiki/Beta_decay) | [22Ne](https://en.wikipedia.org/wiki/Neon-22) | | **23Na** | 100% | [stable](https://en.wikipedia.org/wiki/Stable_isotope) | | | | **24Na** | trace | 14.96 h | [β−](https://en.wikipedia.org/wiki/Beta_decay) | [24Mg](https://en.wikipedia.org/wiki/Magnesium-24) | | |
| * [view](https://en.wikipedia.org/wiki/Template:Infobox_sodium) * [talk](https://en.wikipedia.org/wiki/Template_talk:Infobox_sodium) * [edit](https://en.wikipedia.org/w/index.php?title=Template:Infobox_sodium&action=edit)   | [references](https://en.wikipedia.org/wiki/List_of_data_references_for_chemical_elements) | |

**Sodium** is a [chemical element](https://en.wikipedia.org/wiki/Chemical_element) with symbol **Na** (from Latin *natrium*) and [atomic number](https://en.wikipedia.org/wiki/Atomic_number) 11. It is a soft, silvery-white, highly reactive [metal](https://en.wikipedia.org/wiki/Metal). Sodium is an [alkali metal](https://en.wikipedia.org/wiki/Alkali_metal), being in [group 1](https://en.wikipedia.org/wiki/Group_1_element) of the periodic table, because it has a single electron in its outer shell that it readily donates, creating a positively charged ion—the Na+ [cation](https://en.wikipedia.org/wiki/Cation). Its only stable [isotope](https://en.wikipedia.org/wiki/Isotope) is 23Na. 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](https://en.wikipedia.org/wiki/Abundance_of_elements_in_Earth%27s_crust) and exists in numerous [minerals](https://en.wikipedia.org/wiki/Minerals) such as [feldspars](https://en.wikipedia.org/wiki/Feldspar), [sodalite](https://en.wikipedia.org/wiki/Sodalite), and [rock salt](https://en.wikipedia.org/wiki/Halite) (NaCl). Many salts of sodium are highly water-soluble: sodium ions have been [leached](https://en.wikipedia.org/wiki/Leaching_(chemistry)) by the action of water from the [Earth's](https://en.wikipedia.org/wiki/Earth) [minerals](https://en.wikipedia.org/wiki/Mineral) over eons, and thus sodium and [chlorine](https://en.wikipedia.org/wiki/Chlorine) are the most common dissolved elements by weight in the oceans.

Sodium was first isolated by [Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy) in 1807 by the [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide). Among many other useful sodium compounds, [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide) ([lye](https://en.wikipedia.org/wiki/Lye)) is used in [soap manufacture](https://en.wikipedia.org/wiki/Soap), and [sodium chloride](https://en.wikipedia.org/wiki/Sodium_chloride) ([edible salt](https://en.wikipedia.org/wiki/Edible_salt)) is a [de-icing](https://en.wikipedia.org/wiki/De-ice) agent and a nutrient for animals including humans.

Sodium is an [essential element](https://en.wikipedia.org/wiki/Dietary_mineral) for all animals and some plants. Sodium ions are the major cation in the [extracellular fluid](https://en.wikipedia.org/wiki/Extracellular_fluid) (ECF) and as such are the major contributor to the ECF [osmotic pressure](https://en.wikipedia.org/wiki/Osmotic_pressure) and ECF compartment volume. Loss of water from the ECF compartment increases the sodium concentration, a condition called [hypernatremia](https://en.wikipedia.org/wiki/Hypernatremia). [Isotonic](https://en.wikipedia.org/wiki/Tonicity) loss of water and sodium from the ECF compartment decreases the size of that compartment in a condition called ECF [hypovolemia](https://en.wikipedia.org/wiki/Hypovolemia).

By means of the [sodium-potassium pump](https://en.wikipedia.org/wiki/Na%2B/K%2B-ATPase), 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](https://en.wikipedia.org/wiki/Potassium) measures about 40:1, and sodium, about 1:10. In [nerve cells](https://en.wikipedia.org/wiki/Neuron), the electrical charge across the cell membrane enables transmission of the nerve impulse—an [action potential](https://en.wikipedia.org/wiki/Action_potential)—when the charge is dissipated; sodium plays a key role in that activity.



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**Characteristics**

**Physical**

[https://upload.wikimedia.org/wikipedia/commons/thumb/0/0a/Na-D-sodium_D-lines-589nm.jpg/220px-Na-D-sodium_D-lines-589nm.jpg](https://en.wikipedia.org/wiki/File:Na-D-sodium_D-lines-589nm.jpg)

[Emission spectrum](https://en.wikipedia.org/wiki/Emission_spectrum) for sodium, showing the [D line](https://en.wikipedia.org/wiki/Fraunhofer_lines).

Sodium at [standard temperature and pressure](https://en.wikipedia.org/wiki/Standard_temperature_and_pressure) is a soft silvery metal that combines with oxygen in the air and forms grayish white [sodium oxide](https://en.wikipedia.org/wiki/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](https://en.wikipedia.org/wiki/Metallic_bonding) and free electrons, which carry energy. Due to having low atomic mass 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]](https://en.wikipedia.org/wiki/Sodium#cite_note-Greenwood75-4) 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]](https://en.wikipedia.org/wiki/Sodium#cite_note-5) These properties change dramatically at elevated pressures: at 1.5 [Mbar](https://en.wikipedia.org/wiki/Bar_(unit)), 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](https://en.wikipedia.org/wiki/Allotrope) are insulators and [electrides](https://en.wikipedia.org/wiki/Electride).[[6]](https://en.wikipedia.org/wiki/Sodium#cite_note-6)

[](https://en.wikipedia.org/wiki/File:Flametest--Na.swn.jpg)

A positive [flame test](https://en.wikipedia.org/wiki/Flame_test) for sodium has a bright yellow color.

In a [flame test](https://en.wikipedia.org/wiki/Flame_test), sodium and its compounds glow yellow[[7]](https://en.wikipedia.org/wiki/Sodium#cite_note-7) because the excited [3s](https://en.wikipedia.org/wiki/Atomic_orbital) electrons of sodium emit a [photon](https://en.wikipedia.org/wiki/Photon) when they fall from 3p to 3s; the wavelength of this photon corresponds to the [D line](https://en.wikipedia.org/wiki/D2_line) at about 589.3 nm. [Spin-orbit interactions](https://en.wikipedia.org/wiki/Spin-orbit_interaction) involving the electron in the 3p orbital split the D line into two, at 589.0 and 589.6 nm; [hyperfine structures](https://en.wikipedia.org/wiki/Hyperfine_structure) involving both orbitals cause many more lines.[[8]](https://en.wikipedia.org/wiki/Sodium#cite_note-Citron-PRL-1977-8)

**Isotopes**

Main article: [Isotopes of sodium](https://en.wikipedia.org/wiki/Isotopes_of_sodium)

Twenty isotopes of sodium are known, but only 23Na is stable. 23Na is created in the [carbon-burning process](https://en.wikipedia.org/wiki/Carbon-burning_process) in stars by fusing two [carbon](https://en.wikipedia.org/wiki/Carbon) atoms together; this requires temperatures above 600 megakelvins and a star of at least three solar masses.[[9]](https://en.wikipedia.org/wiki/Sodium#cite_note-9) Two [radioactive](https://en.wikipedia.org/wiki/Radioactive_decay), [cosmogenic](https://en.wikipedia.org/wiki/Cosmogenic) isotopes are the byproduct of [cosmic ray spallation](https://en.wikipedia.org/wiki/Cosmic_ray_spallation): 22Na has a [half-life](https://en.wikipedia.org/wiki/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]](https://en.wikipedia.org/wiki/Sodium#cite_note-10) Two [nuclear isomers](https://en.wikipedia.org/wiki/Nuclear_isomer) have been discovered, the longer-lived one being 24mNa with a half-life of around 20.2 milliseconds. Acute neutron radiation, as from a nuclear [criticality accident](https://en.wikipedia.org/wiki/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]](https://en.wikipedia.org/wiki/Sodium#cite_note-11)

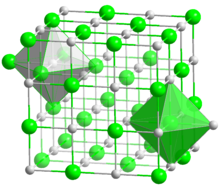
**Chemistry**

Sodium atoms have 11 electrons, one more than the extremely stable configuration of the [noble gas](https://en.wikipedia.org/wiki/Noble_gas) [neon](https://en.wikipedia.org/wiki/Neon). Because of this and its low first [ionization energy](https://en.wikipedia.org/wiki/Ionization_energy) of 495.8 kJ/mol, the sodium atom is much more likely to lose the last electron and acquire a positive charge than to gain one and acquire a negative charge. This process requires so little energy that sodium is readily oxidized by giving up its 11th electron. In contrast, the second ionization energy is very high (4562 kJ/mol), because the 10th electron is closer to the nucleus than the 11th electron. As a result, sodium usually forms [ionic compounds](https://en.wikipedia.org/wiki/Ionic_compound) involving the Na+ cation.[[12]](https://en.wikipedia.org/wiki/Sodium#cite_note-12)

The most common oxidation state for sodium is +1. It is generally less reactive than [potassium](https://en.wikipedia.org/wiki/Potassium) and more reactive than [lithium](https://en.wikipedia.org/wiki/Lithium).[[13]](https://en.wikipedia.org/wiki/Sodium#cite_note-13) Sodium metal is highly reducing, with the [standard reduction potential](https://en.wikipedia.org/wiki/Standard_reduction_potential) for the Na+/Na couple being −2.71 volts,[[14]](https://en.wikipedia.org/wiki/Sodium#cite_note-14) though potassium and lithium have even more negative potentials.[[15]](https://en.wikipedia.org/wiki/Sodium#cite_note-15)

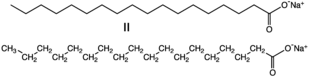
**Salts and oxides**

See also: [Category:Sodium compounds](https://en.wikipedia.org/wiki/Category:Sodium_compounds).

[](https://en.wikipedia.org/wiki/File:NaCl_polyhedra.png)

Structure of [sodium chloride](https://en.wikipedia.org/wiki/Sodium_chloride), showing octahedral coordination around Na+ and Cl− centres. This framework disintegrates when dissolved in water and reassembles when the water evaporates.

Sodium compounds are of immense commercial importance, being particularly central to industries producing [glass](https://en.wikipedia.org/wiki/Glass), [paper](https://en.wikipedia.org/wiki/Paper), [soap](https://en.wikipedia.org/wiki/Soap), and [textiles](https://en.wikipedia.org/wiki/Textile).[[16]](https://en.wikipedia.org/wiki/Sodium#cite_note-Ullmann-16) The most important sodium compounds are [table salt](https://en.wikipedia.org/wiki/Table_salt) (Na[Cl](https://en.wikipedia.org/wiki/Chloride)), [soda ash](https://en.wikipedia.org/wiki/Soda_ash) (Na2[CO3](https://en.wikipedia.org/wiki/Carbonate)), [baking soda](https://en.wikipedia.org/wiki/Baking_soda) (Na[HCO3](https://en.wikipedia.org/wiki/Bicarbonate)), [caustic soda](https://en.wikipedia.org/wiki/Sodium_hydroxide) (NaOH), [sodium nitrate](https://en.wikipedia.org/wiki/Sodium_nitrate) (Na[NO3](https://en.wikipedia.org/wiki/Nitrate)), di- and tri-sodium phosphates, [sodium thiosulfate](https://en.wikipedia.org/wiki/Sodium_thiosulfate) (Na2[S2O3](https://en.wikipedia.org/wiki/Thiosulfate)·5H2O), and [borax](https://en.wikipedia.org/wiki/Borax) (Na2[B](https://en.wikipedia.org/wiki/Boron)4O7·10H2O).[[17]](https://en.wikipedia.org/wiki/Sodium#cite_note-Holl-17) In compounds, sodium is usually [ionically bonded](https://en.wikipedia.org/wiki/Ionic_bond) to water and anions and is viewed as a [hard](https://en.wikipedia.org/wiki/HSAB) [Lewis acid](https://en.wikipedia.org/wiki/Lewis_acid).[[18]](https://en.wikipedia.org/wiki/Sodium#cite_note-18)

[](https://en.wikipedia.org/wiki/File:SodiumSterateChemStr.png)

Two equivalent images of the chemical structure of [sodium stearate](https://en.wikipedia.org/wiki/Sodium_stearate), a typical soap.

Most [soaps](https://en.wikipedia.org/wiki/Soap) are sodium salts of [fatty acids](https://en.wikipedia.org/wiki/Fatty_acid). Sodium soaps have a higher melting temperature (and seem "harder") than potassium soaps.[[17]](https://en.wikipedia.org/wiki/Sodium#cite_note-Holl-17)

Like all the [alkali metals](https://en.wikipedia.org/wiki/Alkali_metal), sodium reacts [exothermically](https://en.wikipedia.org/wiki/Exothermic_reaction) with water, and sufficiently large pieces melt to a sphere and may explode. The reaction produces caustic soda ([sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide)) and flammable [hydrogen](https://en.wikipedia.org/wiki/Hydrogen) gas. When burned in air, it forms primarily [sodium peroxide](https://en.wikipedia.org/wiki/Sodium_peroxide) with some [sodium oxide](https://en.wikipedia.org/wiki/Sodium_oxide).[[19]](https://en.wikipedia.org/wiki/Sodium#cite_note-Greenwood84-19)

**Aqueous solutions**

Sodium tends to form water-soluble compounds, such as [halides](https://en.wikipedia.org/wiki/Halides), [sulfates](https://en.wikipedia.org/wiki/Sulfate), [nitrates](https://en.wikipedia.org/wiki/Nitrates), [carboxylates](https://en.wikipedia.org/wiki/Carboxylates) and [carbonates](https://en.wikipedia.org/wiki/Carbonate). The main aqueous species are the aquo complexes [Na(H2O)*n*]+, where *n* = 4–8; with *n* = 6 indicated from X-ray diffraction data and computer simulations.[[20]](https://en.wikipedia.org/wiki/Sodium#cite_note-Lincoln-20)

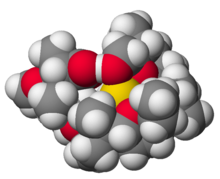
Direct precipitation of sodium salts from aqueous solutions is rare because sodium salts typically have a high affinity for water; an exception is [sodium bismuthate](https://en.wikipedia.org/wiki/Sodium_bismuthate) (NaBiO3).[[21]](https://en.wikipedia.org/wiki/Sodium#cite_note-21) Because of this, sodium salts are usually isolated as solids by evaporation or by precipitation with an organic solvent, such as [ethanol](https://en.wikipedia.org/wiki/Ethanol); for example, only 0.35 g/L of sodium chloride will dissolve in ethanol.[[22]](https://en.wikipedia.org/wiki/Sodium#cite_note-22) [Crown ethers](https://en.wikipedia.org/wiki/Crown_ether), like [15-crown-5](https://en.wikipedia.org/wiki/15-crown-5), may be used as a [phase-transfer catalyst](https://en.wikipedia.org/wiki/Phase-transfer_catalyst).[[23]](https://en.wikipedia.org/wiki/Sodium#cite_note-23)

Sodium content in bulk may be determined by treating with a large excess of [uranyl zinc acetate](https://en.wikipedia.org/wiki/Uranyl_zinc_acetate); the hexahydrate (UO2)2ZnNa(CH3CO2)·6H2O precipitates and [can be weighed](https://en.wikipedia.org/wiki/Gravimetry). Caesium and rubidium do not interfere with this reaction, but potassium and lithium do.[[24]](https://en.wikipedia.org/wiki/Sodium#cite_note-24) Lower concentrations of sodium may be determined by [atomic absorption spectrophotometry](https://en.wikipedia.org/wiki/Atomic_absorption_spectrophotometry)[[25]](https://en.wikipedia.org/wiki/Sodium#cite_note-25) or by [potentiometry](https://en.wikipedia.org/wiki/Potentiometry) using ion-selective electrodes.[[26]](https://en.wikipedia.org/wiki/Sodium#cite_note-26)

**Electrides and sodides**

Like the other alkali metals, sodium dissolves in ammonia and some amines to give deeply colored solutions; evaporation of these solutions leaves a shiny film of metallic sodium. The solutions contain the [coordination complex](https://en.wikipedia.org/wiki/Coordination_complex) (Na(NH3)6)+, with the positive charge counterbalanced by [electrons as anions](https://en.wikipedia.org/wiki/Electride); [cryptands](https://en.wikipedia.org/wiki/Cryptand) permit the isolation of these complexes as crystalline solids. Sodium forms complexes with crown ethers, cryptands and other ligands.[[27]](https://en.wikipedia.org/wiki/Sodium#cite_note-27) For example, [15-crown-5](https://en.wikipedia.org/wiki/15-crown-5) has a high affinity for sodium because the cavity size of 15-crown-5 is 1.7–2.2 Å, which is enough to fit sodium ion (1.9 Å).[[28]](https://en.wikipedia.org/wiki/Sodium#cite_note-28)[[29]](https://en.wikipedia.org/wiki/Sodium#cite_note-29) Cryptands, like crown ethers and other [ionophores](https://en.wikipedia.org/wiki/Ionophore), also have a high affinity for the sodium ion; derivatives of the [alkalide](https://en.wikipedia.org/wiki/Alkalide) Na− are obtainable[[30]](https://en.wikipedia.org/wiki/Sodium#cite_note-30) by the addition of cryptands to solutions of sodium in ammonia via [disproportionation](https://en.wikipedia.org/wiki/Disproportionation).[[31]](https://en.wikipedia.org/wiki/Sodium#cite_note-31)

**Organosodium compounds**

[](https://en.wikipedia.org/wiki/File:Monensin2.png)

The structure of the complex of sodium (Na+, shown in yellow) and the antibiotic [monensin](https://en.wikipedia.org/wiki/Monensin)-A.

Many organosodium compounds have been prepared. Because of the high polarity of the C-Na bonds, they behave like sources of [carbanions](https://en.wikipedia.org/wiki/Carbanion) (salts with organic [anions](https://en.wikipedia.org/wiki/Anion)). Some well-known derivatives include [sodium cyclopentadienide](https://en.wikipedia.org/wiki/Sodium_cyclopentadienide) (NaC5H5) and trityl sodium ((C6H5)3CNa).[[32]](https://en.wikipedia.org/wiki/Sodium#cite_note-32) Because of the large size and very low polarising power of the Na+ cation, it can stabilize large, aromatic, polarisable radical anions, such as in [sodium naphthalenide](https://en.wikipedia.org/wiki/Sodium_naphthalenide), Na+[C10H8•]−, a strong reducing agent.[[33]](https://en.wikipedia.org/wiki/Sodium#cite_note-33)

**Intermetallic compounds**

Sodium forms alloys with many metals, such as potassium, [calcium](https://en.wikipedia.org/wiki/Calcium), [lead](https://en.wikipedia.org/wiki/Lead), and the [group 11](https://en.wikipedia.org/wiki/Group_11_element) and [12](https://en.wikipedia.org/wiki/Group_12_elements) elements. Sodium and potassium form KNa2 and [NaK](https://en.wikipedia.org/wiki/NaK). NaK is 40–90% potassium and it is liquid at [ambient temperature](https://en.wikipedia.org/wiki/Ambient_temperature). It is an excellent thermal and electrical conductor. Sodium-calcium alloys are by-products of the electrolytic production of sodium from a binary salt mixture of NaCl-CaCl2 and ternary mixture NaCl-CaCl2-BaCl2. Calcium is only partially [miscible](https://en.wikipedia.org/wiki/Miscible) with sodium. In a liquid state, sodium is completely miscible with lead. There are several methods to make sodium-lead alloys. One is to melt them together and another is to deposit sodium electrolytically on molten lead cathodes. NaPb3, NaPb, Na9Pb4, Na5Pb2, and Na15Pb4 are some of the known sodium-lead alloys. Sodium also forms alloys with [gold](https://en.wikipedia.org/wiki/Gold) (NaAu2) and [silver](https://en.wikipedia.org/wiki/Silver) (NaAg2). Group 12 metals ([zinc](https://en.wikipedia.org/wiki/Zinc), [cadmium](https://en.wikipedia.org/wiki/Cadmium) and [mercury](https://en.wikipedia.org/wiki/Mercury_(element))) are known to make alloys with sodium. NaZn13 and NaCd2 are alloys of zinc and cadmium. Sodium and mercury form NaHg, NaHg4, NaHg2, Na3Hg2, and Na3Hg.[[34]](https://en.wikipedia.org/wiki/Sodium#cite_note-34)

**History**

Because of its importance in human metabolism, salt has long been an important commodity, as shown by the English word *salary*, which derives from *salarium*, the wafers of salt sometimes given to Roman soldiers along with their other wages. In medieval Europe, a compound of sodium with the Latin name of *sodanum* was used as a [headache](https://en.wikipedia.org/wiki/Headache) remedy. The name sodium is thought to originate from the Arabic *suda*, meaning headache, as the headache-alleviating properties of sodium carbonate or soda were well known in early times.[[35]](https://en.wikipedia.org/wiki/Sodium#cite_note-newton-35) Although sodium, sometimes called *soda*, had long been recognized in compounds, the metal itself was not isolated until 1807 by [Sir Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy) through the [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide).[[36]](https://en.wikipedia.org/wiki/Sodium#cite_note-Davy1807-36)[[37]](https://en.wikipedia.org/wiki/Sodium#cite_note-weeks-37) In 1809, the German physicist and chemist [Ludwig Wilhelm Gilbert](https://en.wikipedia.org/wiki/Ludwig_Wilhelm_Gilbert) proposed the names *Natronium* for Humphry Davy's "sodium" and *Kalium* for Davy's "potassium".[[38]](https://en.wikipedia.org/wiki/Sodium#cite_note-38) The chemical abbreviation for sodium was first published in 1814 by [Jöns Jakob Berzelius](https://en.wikipedia.org/wiki/J%C3%B6ns_Jakob_Berzelius) in his system of atomic symbols,[[39]](https://en.wikipedia.org/wiki/Sodium#cite_note-39)[[40]](https://en.wikipedia.org/wiki/Sodium#cite_note-40) and is an abbreviation of the element's [New Latin](https://en.wikipedia.org/wiki/New_Latin) name *natrium*, which refers to the Egyptian [*natron*](https://en.wikipedia.org/wiki/Natron),[[35]](https://en.wikipedia.org/wiki/Sodium#cite_note-newton-35) a natural mineral salt mainly consisting of hydrated sodium carbonate. Natron historically had several important industrial and household uses, later eclipsed by other sodium compounds.[[41]](https://en.wikipedia.org/wiki/Sodium#cite_note-41)

Sodium imparts an intense yellow color to flames. As early as 1860, [Kirchhoff](https://en.wikipedia.org/wiki/Gustav_Kirchhoff) and [Bunsen](https://en.wikipedia.org/wiki/Robert_Bunsen) noted the high sensitivity of a sodium flame test, and stated in [Annalen der Physik und Chemie](https://en.wikipedia.org/wiki/Annalen_der_Physik):[[42]](https://en.wikipedia.org/wiki/Sodium#cite_note-bunsen1-42)

In a corner of our 60 m3 room farthest away from the apparatus, we exploded 3 mg of sodium chlorate with milk sugar while observing the nonluminous flame before the slit. After a while, it glowed a bright yellow and showed a strong sodium line that disappeared only after 10 minutes. From the weight of the sodium salt and the volume of air in the room, we easily calculate that one part by weight of air could not contain more than 1/20 millionth weight of sodium.

**Occurrence**

The Earth's crust contains 2.27% sodium, making it the [seventh most abundant element](https://en.wikipedia.org/wiki/Abundance_of_the_chemical_elements) on Earth and the fifth most abundant metal, behind [aluminium](https://en.wikipedia.org/wiki/Aluminium), [iron](https://en.wikipedia.org/wiki/Iron), [calcium](https://en.wikipedia.org/wiki/Calcium), and [magnesium](https://en.wikipedia.org/wiki/Magnesium) and ahead of potassium.[[43]](https://en.wikipedia.org/wiki/Sodium#cite_note-Greenwood69-43) Sodium's estimated oceanic abundance is 1.08×104 milligrams per liter.[[44]](https://en.wikipedia.org/wiki/Sodium#cite_note-abundancecrc-44) Because of its high reactivity, it is never found as a pure element. It is found in many different minerals, some very soluble, such as [halite](https://en.wikipedia.org/wiki/Halite) and [natron](https://en.wikipedia.org/wiki/Natron), others much less soluble, such as [amphibole](https://en.wikipedia.org/wiki/Amphibole) and [zeolite](https://en.wikipedia.org/wiki/Zeolite). The insolubility of certain sodium minerals such as [cryolite](https://en.wikipedia.org/wiki/Cryolite) and [feldspar](https://en.wikipedia.org/wiki/Feldspar) arises from their polymeric anions, which in the case of feldspar is a polysilicate.

**Astronomical observations**

Atomic sodium has a very strong [spectral line](https://en.wikipedia.org/wiki/Spectral_line) in the yellow-orange part of the spectrum (the same line as is used in [sodium vapour street lights](https://en.wikipedia.org/wiki/Sodium-vapor_lamp)). This appears as an [absorption line](https://en.wikipedia.org/wiki/Absorption_line) in many types of stars, including the [Sun](https://en.wikipedia.org/wiki/Sun). The line was first studied in 1814 by [Joseph von Fraunhofer](https://en.wikipedia.org/wiki/Joseph_von_Fraunhofer) during his investigation of the lines in the solar spectrum, now known as the [Fraunhofer lines](https://en.wikipedia.org/wiki/Fraunhofer_lines). Fraunhofer named it the 'D line', although it is now known to actually be a group of closely spaced lines split by a [fine](https://en.wikipedia.org/wiki/Fine_structure) and [hyperfine structure](https://en.wikipedia.org/wiki/Hyperfine_structure).[[45]](https://en.wikipedia.org/wiki/Sodium#cite_note-45)

The strength of the D line means it has been detected in many other astronomical environments. In stars, it is seen in any whose surfaces are cool enough for sodium to exist in atomic form (rather than ionised). This corresponds to stars of roughly [F-type](https://en.wikipedia.org/wiki/F-type_main_sequence_star) and cooler. Many other stars appear to have a sodium absorption line, but this is actually caused by gas in the foreground [interstellar medium](https://en.wikipedia.org/wiki/Interstellar_medium). The two can be distinguished via high-resolution spectroscopy, because interstellar lines are much narrower than those broadened by [stellar rotation](https://en.wikipedia.org/wiki/Stellar_rotation).[[46]](https://en.wikipedia.org/wiki/Sodium#cite_note-46)

Sodium has also been detected in numerous [Solar System](https://en.wikipedia.org/wiki/Solar_System) environments, including [Mercury's](https://en.wikipedia.org/wiki/Mercury_(planet)) atmosphere,[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] the [exosphere](https://en.wikipedia.org/wiki/Exosphere) of the [Moon](https://en.wikipedia.org/wiki/Moon),[[47]](https://en.wikipedia.org/wiki/Sodium#cite_note-47) and numerous other bodies. Some [comets](https://en.wikipedia.org/wiki/Comet) have a [sodium tail](https://en.wikipedia.org/wiki/Comet_tail),[[48]](https://en.wikipedia.org/wiki/Sodium#cite_note-48) which was first detected in observations of [Comet Hale-Bopp](https://en.wikipedia.org/wiki/Comet_Hale-Bopp) in 1997.[[49]](https://en.wikipedia.org/wiki/Sodium#cite_note-Cremonese1997-49) Sodium has even been detected in the atmospheres of some [extrasolar planets](https://en.wikipedia.org/wiki/Extrasolar_planet) via [transit spectroscopy](https://en.wikipedia.org/wiki/Transit_spectroscopy).[[50]](https://en.wikipedia.org/wiki/Sodium#cite_note-50)

**Commercial production**

Employed only in rather specialized applications, only about 100,000 tonnes of metallic sodium are produced annually.[[16]](https://en.wikipedia.org/wiki/Sodium#cite_note-Ullmann-16) Metallic sodium was first produced commercially in the late 19th century[[51]](https://en.wikipedia.org/wiki/Sodium#cite_note-51) by [carbothermal reduction](https://en.wikipedia.org/wiki/Carbothermal_reduction) of [sodium carbonate](https://en.wikipedia.org/wiki/Sodium_carbonate) at 1100 °C, as the first step of the [Deville process](https://en.wikipedia.org/wiki/Deville_process) for the production of aluminium:[[52]](https://en.wikipedia.org/wiki/Sodium#cite_note-kirk-52)[[53]](https://en.wikipedia.org/wiki/Sodium#cite_note-53)[[54]](https://en.wikipedia.org/wiki/Sodium#cite_note-54)

Na2CO3 + 2 C → 2 Na + 3 CO

The high demand for aluminium created the need for the production of sodium. The introduction of the [Hall–Héroult process](https://en.wikipedia.org/wiki/Hall%E2%80%93H%C3%A9roult_process) for the production of aluminium by [electrolysing](https://en.wikipedia.org/wiki/Electrolysis) a molten salt bath ended the need for large quantities of sodium. A related process based on the reduction of sodium hydroxide was developed in 1886.[[52]](https://en.wikipedia.org/wiki/Sodium#cite_note-kirk-52)

Sodium is now produced commercially through the [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of molten [sodium chloride](https://en.wikipedia.org/wiki/Sodium_chloride), based on a process patented in 1924.[[55]](https://en.wikipedia.org/wiki/Sodium#cite_note-pauling-55)[[56]](https://en.wikipedia.org/wiki/Sodium#cite_note-losal-56) This is done in a [Downs cell](https://en.wikipedia.org/wiki/Downs_Cell) in which the NaCl is mixed with [calcium chloride](https://en.wikipedia.org/wiki/Calcium_chloride) to lower the [melting point](https://en.wikipedia.org/wiki/Melting_point) below 700 °C. As [calcium](https://en.wikipedia.org/wiki/Calcium) is less [electropositive](https://en.wikipedia.org/wiki/Electropositive) than sodium, no calcium will be deposited at the cathode.[[57]](https://en.wikipedia.org/wiki/Sodium#cite_note-57) This method is less expensive than the previous [Castner process](https://en.wikipedia.org/wiki/Castner_process) (the electrolysis of [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide)).[[58]](https://en.wikipedia.org/wiki/Sodium#cite_note-58)

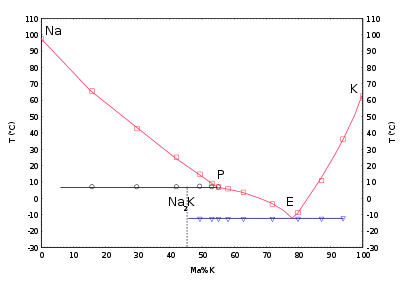
The market for sodium is volatile due to the difficulty in its storage and shipping; it must be stored under a dry [inert gas](https://en.wikipedia.org/wiki/Inert_gas) atmosphere or [anhydrous](https://en.wikipedia.org/wiki/Anhydrous) [mineral oil](https://en.wikipedia.org/wiki/Mineral_oil) to prevent the formation of a surface layer of [sodium oxide](https://en.wikipedia.org/wiki/Sodium_oxide) or [sodium superoxide](https://en.wikipedia.org/wiki/Sodium_superoxide).[[59]](https://en.wikipedia.org/wiki/Sodium#cite_note-59)

**Applications**

Though metallic sodium has some important uses, the major applications for sodium use compounds; millions of tons of [sodium chloride](https://en.wikipedia.org/wiki/Sodium_chloride), [hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide), and [carbonate](https://en.wikipedia.org/wiki/Sodium_carbonate) are produced annually. Sodium chloride is extensively used for [anti-icing](https://en.wikipedia.org/wiki/Anti-icing) and [de-icing](https://en.wikipedia.org/wiki/De-icing) and as a preservative; examples of the uses of [sodium bicarbonate](https://en.wikipedia.org/wiki/Sodium_bicarbonate) include baking, as a raising agent, and [sodablasting](https://en.wikipedia.org/wiki/Sodablasting). Along with potassium, many important medicines have sodium added to improve their [bioavailability](https://en.wikipedia.org/wiki/Bioavailability); though potassium is the better ion in most cases, sodium is chosen for its lower price and atomic weight.[[60]](https://en.wikipedia.org/wiki/Sodium#cite_note-60) [Sodium hydride](https://en.wikipedia.org/wiki/Sodium_hydride) is used as a base for various reactions (such as the [aldol reaction](https://en.wikipedia.org/wiki/Aldol_reaction)) in organic chemistry, and as a reducing agent in inorganic chemistry.[[61]](https://en.wikipedia.org/wiki/Sodium#cite_note-61)

Metallic sodium is used mainly for the production of [sodium borohydride](https://en.wikipedia.org/wiki/Sodium_borohydride), [sodium azide](https://en.wikipedia.org/wiki/Sodium_azide), [indigo](https://en.wikipedia.org/wiki/Indigo_dye), and [triphenylphosphine](https://en.wikipedia.org/wiki/Triphenylphosphine). A once-common use was the making of [tetraethyllead](https://en.wikipedia.org/wiki/Tetraethyllead) and titanium metal; because of the move away from TEL and new titanium production methods, the production of sodium declined after 1970.[[16]](https://en.wikipedia.org/wiki/Sodium#cite_note-Ullmann-16) Sodium is also used as an alloying metal, an [anti-scaling agent](https://en.wikipedia.org/wiki/Anti-scaling_agent),[[62]](https://en.wikipedia.org/wiki/Sodium#cite_note-62) and as a reducing agent for metals when other materials are ineffective. Note the free element is not used as a scaling agent, ions in the water are exchanged for sodium ions. [Sodium plasma ("vapor") lamps](https://en.wikipedia.org/wiki/Sodium_vapor_lamp) are often used for street lighting in cities, shedding light that ranges from yellow-orange to peach as the pressure increases.[[63]](https://en.wikipedia.org/wiki/Sodium#cite_note-63) By itself or [with potassium](https://en.wikipedia.org/wiki/NaK), sodium is a [desiccant](https://en.wikipedia.org/wiki/Desiccant); it gives an intense blue coloration with [benzophenone](https://en.wikipedia.org/wiki/Benzophenone) when the desiccate is dry.[[64]](https://en.wikipedia.org/wiki/Sodium#cite_note-64) In [organic synthesis](https://en.wikipedia.org/wiki/Organic_synthesis), sodium is used in various reactions such as the [Birch reduction](https://en.wikipedia.org/wiki/Birch_reduction), and the [sodium fusion test](https://en.wikipedia.org/wiki/Sodium_fusion_test) is conducted to qualitatively analyse compounds.[[65]](https://en.wikipedia.org/wiki/Sodium#cite_note-65) Sodium reacts with alcohol and gives alkoxides, and when sodium is dissolved in ammonia solution, it can be used to reduce alkynes to trans-alkenes.[[66]](https://en.wikipedia.org/wiki/Sodium#cite_note-66)[[67]](https://en.wikipedia.org/wiki/Sodium#cite_note-67) Lasers emitting light at the sodium D line are used to create artificial [laser guide stars](https://en.wikipedia.org/wiki/Laser_guide_star) that [assist](https://en.wikipedia.org/wiki/FASOR_(laser_physics)) in the [adaptive optics](https://en.wikipedia.org/wiki/Adaptive_optics) for land-based visible-light telescopes.[[68]](https://en.wikipedia.org/wiki/Sodium#cite_note-68)

**Heat transfer**

[](https://en.wikipedia.org/wiki/File:Phase_diagram_potassium_sodium_s_l.svg)

NaK [phase diagram](https://en.wikipedia.org/wiki/Phase_diagram), showing the melting point of sodium as a function of potassium concentration. NaK with 77% potassium is [eutectic](https://en.wikipedia.org/wiki/Eutectic_system) and has the lowest melting point of the NaK alloys at −12.6 °C.[[69]](https://en.wikipedia.org/wiki/Sodium#cite_note-69)

Liquid sodium is used as a [heat transfer fluid](https://en.wikipedia.org/wiki/Coolant) in [some types of nuclear reactors](https://en.wikipedia.org/wiki/Sodium-cooled_fast_reactor)[[70]](https://en.wikipedia.org/wiki/Sodium#cite_note-sodiumcoolant-70) because it has the high thermal conductivity and low neutron absorption [cross section](https://en.wikipedia.org/wiki/Cross_section_(physics)) required to achieve a high neutron flux in the reactor.[[71]](https://en.wikipedia.org/wiki/Sodium#cite_note-nrc-71) The high boiling point of sodium allows the reactor to operate at ambient (normal) pressure,[[71]](https://en.wikipedia.org/wiki/Sodium#cite_note-nrc-71) but the drawbacks include its opacity, which hinders visual maintenance, and its explosive properties.[[72]](https://en.wikipedia.org/wiki/Sodium#cite_note-72) Radioactive [sodium-24](https://en.wikipedia.org/wiki/Sodium-24) may be produced by [neutron bombardment](https://en.wikipedia.org/wiki/Neutron_activation) during operation, posing a slight radiation hazard; the radioactivity stops within a few days after removal from the reactor.[[73]](https://en.wikipedia.org/wiki/Sodium#cite_note-73) If a reactor needs to be shut down frequently, [NaK](https://en.wikipedia.org/wiki/NaK) is used; because NaK is a liquid at room temperature, the coolant does not solidify in the pipes.[[74]](https://en.wikipedia.org/wiki/Sodium#cite_note-74) In this case, the [pyrophoricity](https://en.wikipedia.org/wiki/Pyrophoricity) of potassium requires extra precautions to prevent and detect leaks.[[75]](https://en.wikipedia.org/wiki/Sodium#cite_note-75) Another heat transfer application is [poppet valves](https://en.wikipedia.org/wiki/Poppet_valve) in high-performance internal combustion engines; the valve stems are partially filled with sodium and work as a [heat pipe](https://en.wikipedia.org/wiki/Heat_pipe) to cool the valves.[[76]](https://en.wikipedia.org/wiki/Sodium#cite_note-76)

**Biological role**

Main article: [Sodium in biology](https://en.wikipedia.org/wiki/Sodium_in_biology)

In humans, sodium is an essential mineral that regulates [blood](https://en.wikipedia.org/wiki/Blood) volume, blood pressure, [osmotic](https://en.wikipedia.org/wiki/Osmosis) equilibrium and [pH](https://en.wikipedia.org/wiki/PH); the minimum physiological requirement for sodium is 500 milligrams per day.[[77]](https://en.wikipedia.org/wiki/Sodium#cite_note-r31-77) [Sodium chloride](https://en.wikipedia.org/wiki/Sodium_chloride) is the principal source of sodium in the diet, and is used as seasoning and preservative in such commodities as [pickled preserves](https://en.wikipedia.org/wiki/Pickling) and [jerky](https://en.wikipedia.org/wiki/Jerky_(food)); for Americans, most sodium chloride comes from [processed foods](https://en.wikipedia.org/wiki/Convenience_food).[[78]](https://en.wikipedia.org/wiki/Sodium#cite_note-78) Other sources of sodium are its natural occurrence in food and such food additives as [monosodium glutamate](https://en.wikipedia.org/wiki/Monosodium_glutamate) (MSG), [sodium nitrite](https://en.wikipedia.org/wiki/Sodium_nitrite), sodium saccharin, [baking soda](https://en.wikipedia.org/wiki/Baking_soda) (sodium bicarbonate), and [sodium benzoate](https://en.wikipedia.org/wiki/Sodium_benzoate).[[79]](https://en.wikipedia.org/wiki/Sodium#cite_note-medline-79) The US [Institute of Medicine](https://en.wikipedia.org/wiki/Institute_of_Medicine) set its [Tolerable Upper Intake Level](https://en.wikipedia.org/wiki/Dietary_Reference_Intake) for sodium at 2.3 grams per day,[[80]](https://en.wikipedia.org/wiki/Sodium#cite_note-80) but the average person in the United States consumes 3.4 grams per day.[[81]](https://en.wikipedia.org/wiki/Sodium#cite_note-81) Studies have found that lowering sodium intake by 2 g per day tends to lower [systolic blood pressure](https://en.wikipedia.org/wiki/Systolic_blood_pressure) by about two to four mm Hg.[[82]](https://en.wikipedia.org/wiki/Sodium#cite_note-Impact-82) It has been estimated that such a decrease in sodium intake would lead to between 9 and 17% fewer cases of [hypertension](https://en.wikipedia.org/wiki/Hypertension).[[82]](https://en.wikipedia.org/wiki/Sodium#cite_note-Impact-82)

Hypertension causes 7.6 million premature deaths worldwide each year.[[83]](https://en.wikipedia.org/wiki/Sodium#cite_note-83) (Note that salt contains about 39.3% sodium[[84]](https://en.wikipedia.org/wiki/Sodium#cite_note-84)—the rest being chlorine and trace chemicals; thus, 2.3 g sodium is about 5.9 g, or 2.7 ml of salt—about one [US teaspoon](https://en.wikipedia.org/wiki/US_teaspoon).[[85]](https://en.wikipedia.org/wiki/Sodium#cite_note-85)[[86]](https://en.wikipedia.org/wiki/Sodium#cite_note-fda-86)) The [American Heart Association](https://en.wikipedia.org/wiki/American_Heart_Association) recommends no more than 1.5 g of sodium per day.[[87]](https://en.wikipedia.org/wiki/Sodium#cite_note-87)

One study found that people with or without hypertension who excreted less than 3 grams of sodium per day in their urine (and therefore were taking in less than 3 g/d) had a *higher* risk of death, stroke, or heart attack than those excreting 4 to 5 grams per day. Levels of 7 g per day or more in people with hypertension were associated with higher mortality and cardiovascular events, but this was not found to be true for people without [hypertension](https://en.wikipedia.org/wiki/Hypertension).[[88]](https://en.wikipedia.org/wiki/Sodium#cite_note-88) The [US FDA](https://en.wikipedia.org/wiki/Food_and_Drug_Administration) states that adults with hypertension and prehypertension should reduce daily intake to 1.5 g.[[86]](https://en.wikipedia.org/wiki/Sodium#cite_note-fda-86)

The [renin–angiotensin system](https://en.wikipedia.org/wiki/Renin%E2%80%93angiotensin_system) regulates the amount of fluid and sodium concentration in the body. Reduction of blood pressure and sodium concentration in the kidney result in the production of [renin](https://en.wikipedia.org/wiki/Renin), which in turn produces [aldosterone](https://en.wikipedia.org/wiki/Aldosterone) and [angiotensin](https://en.wikipedia.org/wiki/Angiotensin), retaining sodium in the urine. When the concentration of sodium increases, the production of renin decreases, and the sodium concentration returns to normal.[[89]](https://en.wikipedia.org/wiki/Sodium#cite_note-89) The sodium ion (Na+) is an important electrolyte in [neuron](https://en.wikipedia.org/wiki/Neuron) function, and in osmoregulation between cells and the [extracellular fluid](https://en.wikipedia.org/wiki/Extracellular_fluid). This is accomplished in all animals by [Na+/K+-ATPase](https://en.wikipedia.org/wiki/Na%2B/K%2B-ATPase), an active transporter pumping ions against the gradient, and sodium/potassium channels.[[90]](https://en.wikipedia.org/wiki/Sodium#cite_note-90) Sodium is the most prevalent metallic ion in extracellular fluid.[[91]](https://en.wikipedia.org/wiki/Sodium#cite_note-91)

Unusually low or high sodium levels in humans are recognized in medicine as [hyponatremia](https://en.wikipedia.org/wiki/Hyponatremia) and [hypernatremia](https://en.wikipedia.org/wiki/Hypernatremia). These conditions may be caused by genetic factors, ageing, or prolonged vomiting or diarrhea.[[92]](https://en.wikipedia.org/wiki/Sodium#cite_note-92)

In [C4 plants](https://en.wikipedia.org/wiki/C4_plants), sodium is a [micronutrient](https://en.wikipedia.org/wiki/Micronutrient) that aids metabolism, specifically in regeneration of [phosphoenolpyruvate](https://en.wikipedia.org/wiki/Phosphoenolpyruvic_acid) and synthesis of [chlorophyll](https://en.wikipedia.org/wiki/Chlorophyll).[[93]](https://en.wikipedia.org/wiki/Sodium#cite_note-93) In others, it substitutes for [potassium](https://en.wikipedia.org/wiki/Potassium) in several roles, such as maintaining [turgor pressure](https://en.wikipedia.org/wiki/Turgor_pressure) and aiding in the opening and closing of [stomata](https://en.wikipedia.org/wiki/Stoma).[[94]](https://en.wikipedia.org/wiki/Sodium#cite_note-94) Excess sodium in the soil can limit the uptake of water by decreasing the [water potential](https://en.wikipedia.org/wiki/Water_potential), which may result in plant wilting; excess concentrations in the [cytoplasm](https://en.wikipedia.org/wiki/Cytoplasm) can lead to enzyme inhibition, which in turn causes necrosis and chlorosis.[[95]](https://en.wikipedia.org/wiki/Sodium#cite_note-95) In response, some plants have developed mechanisms to limit sodium uptake in the roots, to store it in cell [vacuoles](https://en.wikipedia.org/wiki/Vacuole), and restrict salt transport from roots to leaves;[[96]](https://en.wikipedia.org/wiki/Sodium#cite_note-halo-96) excess sodium may also be stored in old plant tissue, limiting the damage to new growth. [Halophytes](https://en.wikipedia.org/wiki/Halophytes) have adapted to be able to flourish in sodium rich environments.[[96]](https://en.wikipedia.org/wiki/Sodium#cite_note-halo-96)

**Safety and precautions**

|  |  |
| --- | --- |
| Sodium | |
| **Hazards** | |
| [GHS pictograms](https://en.wikipedia.org/wiki/GHS_hazard_pictograms) | [The flame pictogram in the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)](https://en.wikipedia.org/wiki/File:GHS-pictogram-flamme.svg)[The corrosion pictogram in the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)](https://en.wikipedia.org/wiki/File:GHS-pictogram-acid.svg) |
| [GHS signal word](https://en.wikipedia.org/wiki/Globally_Harmonized_System_of_Classification_and_Labelling_of_Chemicals) | Danger |
| [GHS hazard statements](https://en.wikipedia.org/wiki/GHS_hazard_statement) | H260, H314 |
| [GHS precautionary statements](https://en.wikipedia.org/wiki/GHS_precautionary_statements) | P223, P231+232, P280, P305+351+338, P370+378, P422[[97]](https://en.wikipedia.org/wiki/Sodium#cite_note-97) |
| [NFPA 704](https://en.wikipedia.org/wiki/NFPA_704) | [[98]](https://en.wikipedia.org/wiki/Sodium#cite_note-98)  NFPA 704 four-colored diamond  [2](https://en.wikipedia.org/wiki/NFPA_704#Red)  [3](https://en.wikipedia.org/wiki/NFPA_704#Blue)  [2](https://en.wikipedia.org/wiki/NFPA_704#Yellow)  [~~W~~](https://en.wikipedia.org/wiki/NFPA_704#White) |

Sodium forms flammable hydrogen and caustic [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide) on contact with water;[[99]](https://en.wikipedia.org/wiki/Sodium#cite_note-99) ingestion and contact with moisture on skin, eyes or [mucous membranes](https://en.wikipedia.org/wiki/Mucous_membrane) can cause severe burns.[[100]](https://en.wikipedia.org/wiki/Sodium#cite_note-100)[[101]](https://en.wikipedia.org/wiki/Sodium#cite_note-prudent-101) Sodium spontaneously explodes in the presence of water due to the formation of hydrogen (highly explosive) and sodium hydroxide (which dissolves in the water, liberating more surface). However, sodium exposed to air and ignited or reaching autoignition (reported to occur when a molten pool of sodium reaches about 290 °C)[[102]](https://en.wikipedia.org/wiki/Sodium#cite_note-102) displays a relatively mild fire. In the case of massive (non-molten) pieces of sodium, the reaction with oxygen eventually becomes slow due to formation of a protective layer.[[103]](https://en.wikipedia.org/wiki/Sodium#cite_note-103) [Fire extinguishers](https://en.wikipedia.org/wiki/Fire_extinguisher) based on water accelerate sodium fires; those based on carbon dioxide and [bromochlorodifluoromethane](https://en.wikipedia.org/wiki/Bromochlorodifluoromethane) should not be used on sodium fire.[[101]](https://en.wikipedia.org/wiki/Sodium#cite_note-prudent-101) Metal fires are [Class D](https://en.wikipedia.org/wiki/Fire_extinguisher), but not all Class D extinguishers are workable with sodium. An effective extinguishing agent for sodium fires is [Met-L-X](https://en.wikipedia.org/w/index.php?title=Met-L-X&action=edit&redlink=1).[[101]](https://en.wikipedia.org/wiki/Sodium#cite_note-prudent-101) Other effective agents include Lith-X, which has [graphite](https://en.wikipedia.org/wiki/Graphite) powder and an [organophosphate](https://en.wikipedia.org/wiki/Organophosphate) [flame retardant](https://en.wikipedia.org/wiki/Flame_retardant), and dry sand.[[104]](https://en.wikipedia.org/wiki/Sodium#cite_note-104) Sodium fires are prevented in nuclear reactors by isolating sodium from oxygen by surrounding sodium pipes with inert gas.[[105]](https://en.wikipedia.org/wiki/Sodium#cite_note-fission-105) Pool-type sodium fires are prevented using different design measures called catch pan systems. They collect leaking sodium into a leak-recovery tank where it is isolated from oxygen.[[105]](https://en.wikipedia.org/wiki/Sodium#cite_note-fission-105)

**See also**

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| --- | --- |
| [**Books**](https://en.wikipedia.org/wiki/Wikipedia:Books) View or order collections of articles | * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Sodium***](https://en.wikipedia.org/wiki/Book:Sodium) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Period 3 elements***](https://en.wikipedia.org/wiki/Book:Period_3_elements) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Alkali metals***](https://en.wikipedia.org/wiki/Book:Alkali_metals) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Chemical elements (sorted alphabetically)***](https://en.wikipedia.org/wiki/Book:Chemical_elements_(sorted_alphabetically)) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Chemical elements (sorted by number)***](https://en.wikipedia.org/wiki/Book:Chemical_elements_(sorted_by_number)) |
|  | |
| [**Portals**](https://en.wikipedia.org/wiki/Portal:Contents/Portals) Access related topics | * [Papapishu-Lab-icon-6.svg](https://en.wikipedia.org/wiki/File:Papapishu-Lab-icon-6.svg)[***Chemistry portal***](https://en.wikipedia.org/wiki/Portal:Chemistry) |
|  | |
| Find out more on Wikipedia's [**Sister projects**](https://en.wikipedia.org/wiki/Wikipedia:Wikimedia_sister_projects) | * https://upload.wikimedia.org/wikipedia/en/thumb/4/4a/Commons-logo.svg/22px-Commons-logo.svg.png[Media](https://commons.wikimedia.org/wiki/Special:Search/Sodium) from Commons * https://upload.wikimedia.org/wikipedia/en/thumb/0/06/Wiktionary-logo-v2.svg/30px-Wiktionary-logo-v2.svg.png[Definitions](https://en.wiktionary.org/wiki/Special:Search/sodium#English) from Wiktionary * https://upload.wikimedia.org/wikipedia/commons/thumb/f/fa/Wikibooks-logo.svg/30px-Wikibooks-logo.svg.png[Textbooks](https://en.wikibooks.org/wiki/Special:Search/Wikijunior:The_Elements/Sodium) from Wikibooks * https://upload.wikimedia.org/wikipedia/commons/thumb/9/91/Wikiversity-logo.svg/30px-Wikiversity-logo.svg.png[Learning resources](https://en.wikiversity.org/wiki/Special:Search/Sodium_atom) from Wikiversity |

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