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**Gallium**

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This article is about the chemical element. For other uses, see [Gallium (disambiguation)](https://en.wikipedia.org/wiki/Gallium_(disambiguation)).

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| --- | --- |
| Gallium,  31Ga | |
| [Gallium crystals.jpg](https://en.wikipedia.org/wiki/File:Gallium_crystals.jpg) | |
| **General properties** | |
| **Pronunciation** | [/ˈɡæliəm/](https://en.wikipedia.org/wiki/Help:IPA/English) ​([*GAL-ee-əm*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key)) |
| **Appearance** | silvery blue |
| [**Standard atomic weight**](https://en.wikipedia.org/wiki/Standard_atomic_weight) **(*A*r, standard)** | 69.723(1)[[1]](https://en.wikipedia.org/wiki/Gallium#cite_note-CIAAW2016-1) |
| **Gallium in the** [**periodic table**](https://en.wikipedia.org/wiki/Periodic_table) | |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 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[Neon](https://en.wikipedia.org/wiki/Neon) | | [Sodium](https://en.wikipedia.org/wiki/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 | [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) | | [Al](https://en.wikipedia.org/wiki/Aluminium) ↑ **Ga** ↓ [In](https://en.wikipedia.org/wiki/Indium) | | [zinc](https://en.wikipedia.org/wiki/Zinc) ← **gallium** → [germanium](https://en.wikipedia.org/wiki/Germanium) | | | | |
| [**Atomic number**](https://en.wikipedia.org/wiki/Atomic_number)(*Z*) | 31 |
| [**Group**](https://en.wikipedia.org/wiki/Group_(periodic_table)) | [group 13 (boron group)](https://en.wikipedia.org/wiki/Boron_group) |
| [**Period**](https://en.wikipedia.org/wiki/Period_(periodic_table)) | [period 4](https://en.wikipedia.org/wiki/Period_(periodic_table)#Period_4) |
| [**Block**](https://en.wikipedia.org/wiki/Block_(periodic_table)) | [p-block](https://en.wikipedia.org/wiki/P-block) |
| [**Element category**](https://en.wikipedia.org/wiki/Names_for_sets_of_chemical_elements#Category) | [post-transition metal](https://en.wikipedia.org/wiki/Post-transition_metal) |
| [**Electron configuration**](https://en.wikipedia.org/wiki/Electron_configuration) | [[Ar](https://en.wikipedia.org/wiki/Argon)] 3d10 4s2 4p1 |
| Electrons per shell | 2, 8, 18, 3 |
| **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) | 302.9146 [K](https://en.wikipedia.org/wiki/Kelvin) ​(29.7646 °C, ​85.5763 °F) |
| [**Boiling point**](https://en.wikipedia.org/wiki/Boiling_point) | 2673 K ​(2400 °C, ​4352 °F)[[2]](https://en.wikipedia.org/wiki/Gallium#cite_note-Zhang-2) |
| [**Density**](https://en.wikipedia.org/wiki/Density)(near r.t.) | 5.91 g/cm3 |
| when liquid (at m.p.) | 6.095 g/cm3 |
| [**Heat of fusion**](https://en.wikipedia.org/wiki/Enthalpy_of_fusion) | 5.59 [kJ/mol](https://en.wikipedia.org/wiki/Kilojoule_per_mole) |
| [**Heat of vaporization**](https://en.wikipedia.org/wiki/Enthalpy_of_vaporization) | 256 kJ/mol[[2]](https://en.wikipedia.org/wiki/Gallium#cite_note-Zhang-2) |
| [**Molar heat capacity**](https://en.wikipedia.org/wiki/Molar_heat_capacity) | 25.86 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) | 1310 | 1448 | 1620 | 1838 | 2125 | 2518 | | |
| **Atomic properties** | |
| [**Oxidation states**](https://en.wikipedia.org/wiki/Oxidation_state) | −5, −4, −2, −1, +1, +2, **+3**[[3]](https://en.wikipedia.org/wiki/Gallium#cite_note-3) (an [amphoteric](https://en.wikipedia.org/wiki/Amphoterism) oxide) |
| [**Electronegativity**](https://en.wikipedia.org/wiki/Electronegativity) | Pauling scale: 1.81 |
| [**Ionization energies**](https://en.wikipedia.org/wiki/Ionization_energy) | * 1st: 578.8 kJ/mol * 2nd: 1979.3 kJ/mol * 3rd: 2963 kJ/mol * ([more](https://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements#gallium)) |
| [**Atomic radius**](https://en.wikipedia.org/wiki/Atomic_radius) | empirical: 135 [pm](https://en.wikipedia.org/wiki/Picometre) |
| [**Covalent radius**](https://en.wikipedia.org/wiki/Covalent_radius) | 122±3 pm |
| [**Van der Waals radius**](https://en.wikipedia.org/wiki/Van_der_Waals_radius) | 187 pm |
| [Color lines in a spectral range](https://en.wikipedia.org/wiki/File:Gallium_spectrum_visible.png)  [**Spectral lines**](https://en.wikipedia.org/wiki/Spectral_line) **of gallium** | |
| **Other properties** | |
| [**Crystal structure**](https://en.wikipedia.org/wiki/Crystal_structure) | ​[orthorhombic](https://en.wikipedia.org/wiki/Orthorhombic_crystal_system)  [Orthorhombic crystal structure for gallium](https://en.wikipedia.org/wiki/File:Orthorhombic.svg) |
| [**Speed of sound**](https://en.wikipedia.org/wiki/Speed_of_sound)thin rod | 2740 m/s (at 20 °C) |
| [**Thermal expansion**](https://en.wikipedia.org/wiki/Coefficient_of_thermal_expansion) | 18 µm/(m·K) (at 25 °C) |
| [**Thermal conductivity**](https://en.wikipedia.org/wiki/Thermal_conductivity) | 40.6 W/(m·K) |
| [**Electrical resistivity**](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) | 270 nΩ·m (at 20 °C) |
| [**Magnetic ordering**](https://en.wikipedia.org/wiki/Magnetism) | [diamagnetic](https://en.wikipedia.org/wiki/Diamagnetism) |
| [**Magnetic susceptibility**](https://en.wikipedia.org/wiki/Magnetic_susceptibility) | −21.6·10−6 cm3/mol (at 290 K)[[4]](https://en.wikipedia.org/wiki/Gallium#cite_note-4) |
| [**Young's modulus**](https://en.wikipedia.org/wiki/Young%27s_modulus) | 9.8 GPa |
| [**Poisson ratio**](https://en.wikipedia.org/wiki/Poisson%27s_ratio) | 0.47 |
| [**Mohs hardness**](https://en.wikipedia.org/wiki/Mohs_scale_of_mineral_hardness) | 1.5 |
| [**Brinell hardness**](https://en.wikipedia.org/wiki/Brinell_hardness_test) | 56.8–68.7 MPa |
| [**CAS Number**](https://en.wikipedia.org/wiki/CAS_Registry_Number) | 7440-55-3 |
| **History** | |
| **Naming** | after *Gallia* (Latin for: France), homeland of the discoverer |
| **Prediction** | [Dmitri Mendeleev](https://en.wikipedia.org/wiki/Dmitri_Mendeleev) (1871) |
| [**Discovery**](https://en.wikipedia.org/wiki/Timeline_of_chemical_element_discoveries) **and first isolation** | [Lecoq de Boisbaudran](https://en.wikipedia.org/wiki/Lecoq_de_Boisbaudran) (1875) |
| **Main** [**isotopes of gallium**](https://en.wikipedia.org/wiki/Isotopes_of_gallium) | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | [**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) | | **66Ga** | [syn](https://en.wikipedia.org/wiki/Synthetic_radioisotope) | 9.5 h | [β+](https://en.wikipedia.org/wiki/Beta_plus_decay) | [66Zn](https://en.wikipedia.org/wiki/Zinc-66) | | **67Ga** | syn | 3.3 d | [ε](https://en.wikipedia.org/wiki/Electron_capture) | [67Zn](https://en.wikipedia.org/wiki/Zinc-67) | | **68Ga** | syn | 1.2 h | β+ | [68Zn](https://en.wikipedia.org/wiki/Zinc-68) | | **69Ga** | 60.11% | [stable](https://en.wikipedia.org/wiki/Stable_isotope) | | | | **70Ga** | syn | 21 min | [β−](https://en.wikipedia.org/wiki/Beta_minus_decay) | [70Ge](https://en.wikipedia.org/wiki/Germanium-70) | | ε | [70Zn](https://en.wikipedia.org/wiki/Zinc-70) | | **71Ga** | 39.89% | stable | | | | **72Ga** | syn | 14.1 h | β− | [72Ge](https://en.wikipedia.org/wiki/Germanium-72) | | **73Ga** | syn | 4.9 h | β− | [73Ge](https://en.wikipedia.org/wiki/Germanium-73) | | |
| * [view](https://en.wikipedia.org/wiki/Template:Infobox_gallium) * [talk](https://en.wikipedia.org/wiki/Template_talk:Infobox_gallium) * [edit](https://en.wikipedia.org/w/index.php?title=Template:Infobox_gallium&action=edit)   | [references](https://en.wikipedia.org/wiki/List_of_data_references_for_chemical_elements) | |

**Gallium** is a [chemical element](https://en.wikipedia.org/wiki/Chemical_element) with symbol **Ga** and [atomic number](https://en.wikipedia.org/wiki/Atomic_number) 31. It is in [group 13](https://en.wikipedia.org/wiki/Boron_group) of the periodic table, and thus has similarities to the other metals of the group, [aluminium](https://en.wikipedia.org/wiki/Aluminium), [indium](https://en.wikipedia.org/wiki/Indium), and [thallium](https://en.wikipedia.org/wiki/Thallium). Gallium does not occur as a free element in nature, but as gallium(III) compounds in trace amounts in [zinc](https://en.wikipedia.org/wiki/Zinc) ores and in [bauxite](https://en.wikipedia.org/wiki/Bauxite).[[6]](https://en.wikipedia.org/wiki/Gallium#cite_note-:0-6) Elemental gallium is a soft, silvery blue metal at [standard temperature and pressure](https://en.wikipedia.org/wiki/Standard_conditions_for_temperature_and_pressure), a brittle solid at low temperatures, and a liquid at temperatures greater than 29.76 °C (85.57 °F) (above [room temperature](https://en.wikipedia.org/wiki/Room_temperature), but below the normal human body temperature of 98.6 °F (37.0 °C), hence, the metal will melt in a person's hands).

The melting point of gallium is used as a temperature reference point. Gallium alloys are used in thermometers as a non-toxic and [environmentally friendly](https://en.wikipedia.org/wiki/Environmentally_friendly) alternative to mercury, and can withstand higher temperatures than mercury. The alloy [galinstan](https://en.wikipedia.org/wiki/Galinstan) (70% gallium, 21.5% [indium](https://en.wikipedia.org/wiki/Indium), and 10% [tin](https://en.wikipedia.org/wiki/Tin)) has an even lower melting point of −19 °C (−2 °F), well below the freezing point of water.

Since its discovery in 1875, gallium has been used to make [alloys](https://en.wikipedia.org/wiki/Alloy) with low melting points. It is also used in [semiconductors](https://en.wikipedia.org/wiki/Semiconductor) as a [dopant](https://en.wikipedia.org/wiki/Dopant) in semiconductor substrates.

Gallium is predominantly used in [electronics](https://en.wikipedia.org/wiki/Electronics). [Gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide), the primary [chemical compound](https://en.wikipedia.org/wiki/Chemical_compound) of gallium in electronics, is used in [microwave](https://en.wikipedia.org/wiki/Microwave) circuits, high-speed switching circuits, and [infrared](https://en.wikipedia.org/wiki/Infrared) circuits. Semiconducting [gallium nitride](https://en.wikipedia.org/wiki/Gallium_nitride) and [indium gallium nitride](https://en.wikipedia.org/wiki/Indium_gallium_nitride) produce blue and violet [light-emitting diodes](https://en.wikipedia.org/wiki/Light-emitting_diode) (LEDs) and [diode lasers](https://en.wikipedia.org/wiki/Diode_laser). Gallium is also used in the production of artificial [gadolinium gallium garnet](https://en.wikipedia.org/wiki/Gadolinium_gallium_garnet) for jewelry.

Gallium has no known natural role in biology. Gallium(III) behaves in a similar manner to [ferric](https://en.wikipedia.org/wiki/Ferric#Ferric_iron_and_life) salts in biological systems and has been used in some medical applications, including pharmaceuticals and [radiopharmaceuticals](https://en.wikipedia.org/wiki/Radiopharmacology).



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**Physical properties**

[](https://en.wikipedia.org/wiki/File:Gallium_kristallisiert.JPG)

Crystallization of gallium from the melt

Elemental gallium is not found in nature, but it is easily obtained by [smelting](https://en.wikipedia.org/wiki/Smelting). Very pure gallium metal has a silvery color and its solid metal fractures [conchoidally](https://en.wikipedia.org/wiki/Conchoidal_fracture) like [glass](https://en.wikipedia.org/wiki/Glass). Gallium liquid expands by 3.10% when it solidifies; therefore, it should not be stored in glass or metal containers because the container may rupture when the gallium changes state. Gallium shares the higher-density liquid state with a short list of other materials that includes [water](https://en.wikipedia.org/wiki/Properties_of_water), [silicon](https://en.wikipedia.org/wiki/Silicon), [germanium](https://en.wikipedia.org/wiki/Germanium), [antimony](https://en.wikipedia.org/wiki/Antimony), [bismuth](https://en.wikipedia.org/wiki/Bismuth), and [plutonium](https://en.wikipedia.org/wiki/Plutonium).[[7]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood222-7)

Gallium [attacks](https://en.wikipedia.org/wiki/Liquid_metal_embrittlement) most other metals by [diffusing](https://en.wikipedia.org/wiki/Diffusion) into the metal [lattice](https://en.wikipedia.org/wiki/Crystal_structure). For example, it diffuses into the [grain boundaries](https://en.wikipedia.org/wiki/Grain_boundary) of [aluminium](https://en.wikipedia.org/wiki/Aluminium)-[zinc](https://en.wikipedia.org/wiki/Zinc) [alloys](https://en.wikipedia.org/wiki/Alloy)[[8]](https://en.wikipedia.org/wiki/Gallium#cite_note-8) and [steel](https://en.wikipedia.org/wiki/Steel),[[9]](https://en.wikipedia.org/wiki/Gallium#cite_note-9) making them very brittle. Gallium easily alloys with many metals, and is used in small quantities in the [plutonium-gallium alloy](https://en.wikipedia.org/wiki/Plutonium-gallium_alloy) in the plutonium [cores](https://en.wikipedia.org/wiki/Plutonium_pit) of [nuclear bombs](https://en.wikipedia.org/wiki/Nuclear_weapon) to stabilize the plutonium crystal structure.[[10]](https://en.wikipedia.org/wiki/Gallium#cite_note-10)

The [melting point](https://en.wikipedia.org/wiki/Melting_point) of gallium, at 302.9146 K (29.7646 °C, 85.5763 °F), is just above room temperature, and is approximately the same as the average summer daytime temperatures in Earth's mid-latitudes. This melting point (mp) is one of the formal temperature reference points in the [International Temperature Scale of 1990](https://en.wikipedia.org/wiki/International_Temperature_Scale_of_1990) (ITS-90) established by the [International Bureau of Weights and Measures](https://en.wikipedia.org/wiki/International_Bureau_of_Weights_and_Measures) (BIPM).[[11]](https://en.wikipedia.org/wiki/Gallium#cite_note-11)[[12]](https://en.wikipedia.org/wiki/Gallium#cite_note-12)[[13]](https://en.wikipedia.org/wiki/Gallium#cite_note-13) The [triple point](https://en.wikipedia.org/wiki/Triple_point) of gallium, 302.9166 K (29.7666 °C, 85.5799 °F), is used by the US [National Institute of Standards and Technology](https://en.wikipedia.org/wiki/National_Institute_of_Standards_and_Technology) (NIST) in preference to the melting point.[[14]](https://en.wikipedia.org/wiki/Gallium#cite_note-14)

The melting point of gallium allows it to melt in the human hand, and then refreeze if removed. The liquid metal has a strong tendency to [supercool](https://en.wikipedia.org/wiki/Supercooling) below its [melting point](https://en.wikipedia.org/wiki/Melting_point)/[freezing point](https://en.wikipedia.org/wiki/Freezing_point): Ga nanoparticles can be kept in the liquid state below 90 K.[[15]](https://en.wikipedia.org/wiki/Gallium#cite_note-15) [Seeding](https://en.wikipedia.org/wiki/Seed_crystal) with a crystal helps to initiate freezing. Gallium is one of the four non-radioactive metals (with [caesium](https://en.wikipedia.org/wiki/Caesium), [rubidium](https://en.wikipedia.org/wiki/Rubidium), and [mercury](https://en.wikipedia.org/wiki/Mercury_(element))) that are known to be liquid at, or near, normal room temperature. Of the four, gallium is the only one that is neither highly reactive (rubidium and caesium) nor highly toxic (mercury) and can therefore be used in metal-in-glass high-temperature [thermometers](https://en.wikipedia.org/wiki/Thermometer). It is also notable for having one of the largest liquid ranges for a metal, and for having (unlike mercury) a low [vapor pressure](https://en.wikipedia.org/wiki/Vapor_pressure) at high temperatures. Gallium's boiling point, 2673 K, is more than eight times higher than its melting point on the [absolute scale](https://en.wikipedia.org/wiki/Absolute_scale), the greatest ratio between melting point and boiling point of any element.[[16]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood224-16) Unlike mercury, liquid gallium metal [wets](https://en.wikipedia.org/wiki/Wetting) glass and skin, along with most other materials (with the exceptions of quartz, graphite, and [Teflon](https://en.wikipedia.org/wiki/Teflon))[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)], making it mechanically more difficult to handle even though it is substantially less toxic and requires far fewer precautions. Gallium painted onto glass is a brilliant mirror.[[17]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood221-17) For this reason as well as the metal contamination and freezing-expansion problems, samples of gallium metal are usually supplied in polyethylene packets within other containers.

|  |  |  |  |
| --- | --- | --- | --- |
| Properties of gallium for different crystal axes[[18]](https://en.wikipedia.org/wiki/Gallium#cite_note-anis-18) | | | |
| **Property** | ***a*** | ***b*** | ***c*** |
| [α](https://en.wikipedia.org/wiki/Thermal_expansion) (~25 °C, µm/m) | 16 | 11 | 31 |
| [ρ](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) (29.7 °C, nΩ·m) | 543 | 174 | 81 |
| ρ (0 °C, nΩ·m) | 480 | 154 | 71.6 |
| ρ (77 K, nΩ·m) | 101 | 30.8 | 14.3 |
| ρ (4.2 K, pΩ·m) | 13.8 | 6.8 | 1.6 |

Gallium does not [crystallize](https://en.wikipedia.org/wiki/Crystal) in any of the simple [crystal structures](https://en.wikipedia.org/wiki/Crystal_structure). The stable phase under normal conditions is [orthorhombic](https://en.wikipedia.org/wiki/Orthorhombic) with 8 atoms in the conventional [unit cell](https://en.wikipedia.org/wiki/Unit_cell). Within a unit cell, each atom has only one nearest neighbor (at a distance of 244 [pm](https://en.wikipedia.org/wiki/Picometre)). The remaining six unit cell neighbors are spaced 27, 30 and 39 pm farther away, and they are grouped in pairs with the same distance.[[19]](https://en.wikipedia.org/wiki/Gallium#cite_note-19) Many stable and [metastable](https://en.wikipedia.org/wiki/Metastability_in_molecules) phases are found as function of temperature and pressure.[[20]](https://en.wikipedia.org/wiki/Gallium#cite_note-20)

The bonding between the two nearest neighbors is [covalent](https://en.wikipedia.org/wiki/Covalent); hence Ga2 [dimers](https://en.wikipedia.org/wiki/Dimer_(chemistry)) are seen as the fundamental building blocks of the crystal. This explains the low melting point relative to the neighbor elements, aluminium and indium. This structure is strikingly similar to that of [iodine](https://en.wikipedia.org/wiki/Iodine) and forms because of interactions between the single 4p electrons of gallium atoms, further away from the nucleus than the 4s electrons and the [Ar]3d10 core. This phenomenon recurs with [mercury](https://en.wikipedia.org/wiki/Mercury_(element)) with its "pseudo-noble-gas" [Xe]4f145d106s2 electron configuration, which is liquid at room temperature.[[21]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood223-21) The 3d10 electrons do not shield the outer electrons very well from the nucleus and hence the first ionisation energy of gallium is greater than that of aluminium.[[7]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood222-7)

The physical properties of gallium are highly anisotropic, i.e. have different values along the three major crystallographical axes *a*, *b*, and *c* (see table), producing a significant difference between the linear (α) and volume [thermal expansion](https://en.wikipedia.org/wiki/Thermal_expansion) coefficients. The properties of gallium are strongly temperature-dependent, particularly near the melting point. For example, the coefficient of thermal expansion increases by several hundred percent upon melting.[[18]](https://en.wikipedia.org/wiki/Gallium#cite_note-anis-18)

**Isotopes**

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

Gallium has 31 known isotopes, ranging in [mass number](https://en.wikipedia.org/wiki/Mass_number) from 56 to 86. Only two isotopes are stable and occur naturally, gallium-69 and gallium-71. Gallium-69 is more abundant: it makes up about 60.1% of natural gallium, while gallium-71 makes up the remaining 39.9%. All the other isotopes are radioactive. The two longest-lived and only commercially important ones are gallium-67 (half-life 3.261 days) and gallium-68 (half-life 67.7 min). Isotopes lighter than gallium-69 usually decay through [beta plus decay](https://en.wikipedia.org/wiki/Beta_plus_decay) (positron emission) or [electron capture](https://en.wikipedia.org/wiki/Electron_capture) to isotopes of [zinc](https://en.wikipedia.org/wiki/Zinc), although the lightest few (with mass numbers 56 through 59) decay through prompt [proton emission](https://en.wikipedia.org/wiki/Proton_emission). Isotopes heavier than gallium-71 decay through [beta minus decay](https://en.wikipedia.org/wiki/Beta_minus_decay) (electron emission), possibly with delayed [neutron emission](https://en.wikipedia.org/wiki/Neutron_emission), to isotopes of [germanium](https://en.wikipedia.org/wiki/Germanium), while gallium-70 can decay through both beta minus decay and electron capture. Gallium-67 is unique among the light isotopes in having only electron capture as a decay mode, as its decay energy is not sufficient to allow positron emission.[[22]](https://en.wikipedia.org/wiki/Gallium#cite_note-Audi-22)

**Chemical properties**

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

Gallium is found primarily in the +3 [oxidation state](https://en.wikipedia.org/wiki/Oxidation_state). The +1 oxidation state is also found in some compounds, although it is less common than it is for gallium's heavier congeners indium and thallium. For example, the very stable GaCl2 contains both gallium(I) and gallium(III) and can be formulated as GaIGaIIICl4; in contrast, the monochloride is unstable above 0 °C, [disproportionating](https://en.wikipedia.org/wiki/Disproportionation) into elemental gallium and gallium(III) chloride. Compounds containing Ga–Ga bonds are true gallium(II) compounds, such as [GaS](https://en.wikipedia.org/wiki/Gallium(II)_sulfide) (which can be formulated as Ga24+(S2−)2) and the [dioxan](https://en.wikipedia.org/wiki/Dioxan) complex Ga2Cl4(C4H8O2)2.[[23]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood240-23)

**Aqueous chemistry**

Strong acids dissolve gallium, forming gallium(III) salts such as [Ga  
2(SO  
4)  
3](https://en.wikipedia.org/w/index.php?title=Gallium_sulfate&action=edit&redlink=1) (gallium sulfate) and [Ga(NO  
3)  
3](https://en.wikipedia.org/wiki/Gallium(III)_nitrate) (gallium nitrate). [Aqueous](https://en.wikipedia.org/wiki/Aqueous) solutions of gallium(III) salts contain the hydrated gallium ion, [Ga(H  
2O)  
6]3+  
.[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1033 [Gallium(III) hydroxide](https://en.wikipedia.org/wiki/Gallium(III)_hydroxide), Ga(OH)  
3, may be precipitated from gallium(III) solutions by adding [ammonia](https://en.wikipedia.org/wiki/Ammonia). Dehydrating Ga(OH)  
3 at 100 °C produces gallium oxide hydroxide, GaO(OH).[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):140–141

Alkaline [hydroxide](https://en.wikipedia.org/wiki/Hydroxide) solutions dissolve gallium, forming *gallate* salts (not to be confused with identically-named [gallic acid](https://en.wikipedia.org/wiki/Gallic_acid) salts) containing the Ga(OH)−  
4 anion.[[26]](https://en.wikipedia.org/wiki/Gallium#cite_note-eagleson-26)[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1033[[27]](https://en.wikipedia.org/wiki/Gallium#cite_note-sipos-27) Gallium hydroxide, which is [amphoteric](https://en.wikipedia.org/wiki/Amphoteric), also dissolves in alkali to form gallate salts.[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):141 Although earlier work suggested Ga(OH)3−  
6 as another possible gallate anion,[[28]](https://en.wikipedia.org/wiki/Gallium#cite_note-28) it was not found in later work.[[27]](https://en.wikipedia.org/wiki/Gallium#cite_note-sipos-27)

**Oxides and chalcogenides**

Gallium reacts with the [chalcogens](https://en.wikipedia.org/wiki/Chalcogen) only at relatively high temperatures. At room temperature, gallium metal is not reactive with air and water because it forms a [passive](https://en.wikipedia.org/wiki/Passivation_(chemistry)), protective [oxide](https://en.wikipedia.org/wiki/Oxide) layer. At higher temperatures, however, it reacts with atmospheric [oxygen](https://en.wikipedia.org/wiki/Oxygen) to form [gallium(III) oxide](https://en.wikipedia.org/wiki/Gallium(III)_oxide), Ga  
2O  
3.[[26]](https://en.wikipedia.org/wiki/Gallium#cite_note-eagleson-26) Reducing Ga  
2O  
3 with elemental gallium in vacuum at 500 °C to 700 °C yields the dark brown [gallium(I) oxide](https://en.wikipedia.org/wiki/Gallium(I)_oxide), Ga  
2O.[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):285 Ga  
2O is a very strong [reducing agent](https://en.wikipedia.org/wiki/Reducing_agent), capable of reducing [H  
2SO  
4](https://en.wikipedia.org/wiki/Sulfuric_acid) to [H  
2S](https://en.wikipedia.org/wiki/Hydrogen_sulfide).[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):207 It disproportionates at 800 °C back to gallium and Ga  
2O  
3.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29)

[Gallium(III) sulfide](https://en.wikipedia.org/wiki/Gallium(III)_sulfide), Ga  
2S  
3, has 3 possible crystal modifications.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):104 It can be made by the reaction of gallium with [hydrogen sulfide](https://en.wikipedia.org/wiki/Hydrogen_sulfide) (H  
2S) at 950 °C.[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):162 Alternatively, Ga(OH)  
3 can be used at 747 °C:[[30]](https://en.wikipedia.org/wiki/Gallium#cite_note-30)

2 Ga(OH)  
3 + 3 H  
2S → Ga  
2S  
3 + 6 H  
2O

Reacting a mixture of alkali metal carbonates and Ga  
2O  
3 with H  
2S leads to the formation of *thiogallates* containing the [Ga  
2S  
4]2−  
anion. Strong acids decompose these salts, releasing H  
2S in the process.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):104–105 The mercury salt, HgGa  
2S  
4, can be used as a [phosphor](https://en.wikipedia.org/wiki/Phosphor).[[31]](https://en.wikipedia.org/wiki/Gallium#cite_note-31)

Gallium also forms sulfides in lower oxidation states, such as [gallium(II) sulfide](https://en.wikipedia.org/wiki/Gallium(II)_sulfide) and the green [gallium(I) sulfide](https://en.wikipedia.org/w/index.php?title=Gallium(I)_sulfide&action=edit&redlink=1), the latter of which is produced from the former by heating to 1000 °C under a stream of nitrogen.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):94

The other binary chalcogenides, Ga  
2Se  
3 and Ga  
2Te  
3, have the [zincblende](https://en.wikipedia.org/wiki/Zincblende_(crystal_structure)) structure. They are all semiconductors but are easily [hydrolysed](https://en.wikipedia.org/wiki/Hydrolysis) and have limited utility.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):104

**Nitrides and pnictides**

[](https://en.wikipedia.org/wiki/File:Crystal-GaN.jpg)

[](https://en.wikipedia.org/wiki/File:Gallium_arsenide_crystal.jpg)

Gallium nitride (*left*) and gallium arsenide (*right*) crystals

Gallium reacts with ammonia at 1050 °C to form [gallium nitride](https://en.wikipedia.org/wiki/Gallium_nitride), GaN. Gallium also forms binary compounds with [phosphorus](https://en.wikipedia.org/wiki/Phosphorus), [arsenic](https://en.wikipedia.org/wiki/Arsenic), and [antimony](https://en.wikipedia.org/wiki/Antimony): [gallium phosphide](https://en.wikipedia.org/wiki/Gallium_phosphide) (GaP), [gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide) (GaAs), and [gallium antimonide](https://en.wikipedia.org/wiki/Gallium_antimonide) (GaSb). These compounds have the same structure as [ZnS](https://en.wikipedia.org/wiki/Zinc_sulfide), and have important [semiconducting](https://en.wikipedia.org/wiki/Semiconductor) properties.[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1034 GaP, GaAs, and GaSb can be synthesized by the direct reaction of gallium with elemental phosphorus, arsenic, or antimony.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):99 They exhibit higher electrical conductivity than GaN.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):101 GaP can also be synthesized by reacting Ga  
2O with phosphorus at low temperatures.[[32]](https://en.wikipedia.org/wiki/Gallium#cite_note-32)

Gallium forms ternary [nitrides](https://en.wikipedia.org/wiki/Nitride); for example:[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):99

Li  
3Ga + N  
2 → Li  
3GaN  
2

Similar compounds with phosphorus and arsenic are possible: Li  
3GaP  
2 and Li  
3GaAs  
2. These compounds are easily hydrolyzed by dilute [acids](https://en.wikipedia.org/wiki/Acid) and water.[[29]](https://en.wikipedia.org/wiki/Gallium#cite_note-emeleus_sharpe-29):101

**Halides**

See also: [Gallium halides](https://en.wikipedia.org/wiki/Gallium_halides)

Gallium(III) oxide reacts with [fluorinating agents](https://en.wikipedia.org/wiki/Halogenation) such as [HF](https://en.wikipedia.org/wiki/Hydrogen_fluoride) or [F  
2](https://en.wikipedia.org/wiki/Fluorine) to form [gallium(III) fluoride](https://en.wikipedia.org/wiki/Gallium(III)_fluoride), GaF  
3. It is an ionic compound strongly insoluble in water. However, it dissolves in [hydrofluoric acid](https://en.wikipedia.org/wiki/Hydrofluoric_acid), in which it forms an [adduct](https://en.wikipedia.org/wiki/Adduct) with water, GaF  
3·3H  
2O. Attempting to dehydrate this adduct forms GaF  
2OH·*n*H  
2O. The adduct reacts with ammonia to form GaF  
3·3NH  
3, which can then be heated to form anhydrous GaF  
3.[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):128–129

[Gallium trichloride](https://en.wikipedia.org/wiki/Gallium_trichloride) is formed by the reaction of gallium metal with [chlorine](https://en.wikipedia.org/wiki/Chlorine) gas.[[26]](https://en.wikipedia.org/wiki/Gallium#cite_note-eagleson-26) Unlike the trifluoride, gallium(III) chloride exists as dimeric molecules, Ga  
2Cl  
6, with a melting point of 78 °C. Eqivalent compounds are formed with bromine and iodine, [Ga  
2Br  
6](https://en.wikipedia.org/wiki/Gallium(III)_bromide) and [Ga  
2I  
6](https://en.wikipedia.org/wiki/Gallium(III)_iodide).[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):133

Like the other group 13 trihalides, gallium(III) halides are [Lewis acids](https://en.wikipedia.org/wiki/Lewis_acid), reacting as halide acceptors with alkali metal halides to form salts containing GaX−  
4 anions, where X is a halogen. They also react with [alkyl halides](https://en.wikipedia.org/wiki/Haloalkane) to form [carbocations](https://en.wikipedia.org/wiki/Carbocation) and GaX−  
4.[[25]](https://en.wikipedia.org/wiki/Gallium#cite_note-downs-25):136–137

When heated to a high temperature, gallium(III) halides react with elemental gallium to form the respective gallium(I) halides. For example, GaCl  
3 reacts with Ga to form GaCl:

2 Ga + GaCl  
3 ⇌ 3 GaCl (g)

At lower temperatures, the equilibrium shifts toward the left and GaCl disproportionates back to elemental gallium and GaCl  
3. GaCl can also be produced by reacting Ga with HCl at 950 °C; the product can be condensed as a red solid.[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1036

Gallium(I) compounds can be stabilized by forming adducts with Lewis acids. For example:

GaCl + AlCl  
3 → Ga+  
[AlCl  
4]−

The so-called "gallium(II) halides", GaX  
2, are actually adducts of gallium(I) halides with the respective gallium(III) halides, having the structure Ga+  
[GaX  
4]−  
. For example:[[26]](https://en.wikipedia.org/wiki/Gallium#cite_note-eagleson-26)[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1036[[33]](https://en.wikipedia.org/wiki/Gallium#cite_note-arora-33)

GaCl + GaCl  
3 → Ga+  
[GaCl  
4]−

**Hydrides**

Like [aluminium](https://en.wikipedia.org/wiki/Aluminium), gallium also forms a [hydride](https://en.wikipedia.org/wiki/Hydride), GaH  
3, known as [*gallane*](https://en.wikipedia.org/wiki/Gallane), which may be produced by reacting lithium gallanate (LiGaH  
4) with [gallium(III) chloride](https://en.wikipedia.org/wiki/Gallium(III)_chloride) at −30 °C:[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1031

3 LiGaH  
4 + GaCl  
3 → 3 LiCl + 4 GaH  
3

In the presence of [dimethyl ether](https://en.wikipedia.org/wiki/Dimethyl_ether) as solvent, GaH  
3 polymerizes to (GaH  
3)  
*n*. If no solvent is used, the dimer Ga  
2H  
6 ([*digallane*](https://en.wikipedia.org/wiki/Digallane)) is formed as a gas. Its structure is similar to [diborane](https://en.wikipedia.org/wiki/Diborane), having two hydrogen atoms bridging the two gallium centers,[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1031 unlike α-[AlH  
3](https://en.wikipedia.org/wiki/Aluminium_hydride) in which aluminium has a coordination number of 6.[[24]](https://en.wikipedia.org/wiki/Gallium#cite_note-wiberg_holleman-24):1008

Gallane is unstable above −10 °C, decomposing to elemental gallium and [hydrogen](https://en.wikipedia.org/wiki/Hydrogen).[[34]](https://en.wikipedia.org/wiki/Gallium#cite_note-sykes-34)

**Organogallium compounds**

Main article: [Organogallium chemistry](https://en.wikipedia.org/wiki/Organogallium_chemistry)

Organogallium compounds are of similar reactivity to organoindium compounds. less reactive than organoaluminium compounds, but more reactive than organothallium compounds.[[35]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood262-35) Alkylgalliums are monomeric. [Lewis acidity](https://en.wikipedia.org/wiki/Lewis_acid) decreases in the order Al > Ga > In and as a result organogallium compounds do not form bridged dimers as organoaluminum compounds do. Organogallium compounds are also less reactive than organoaluminum compounds. They do form stable peroxides.[[36]](https://en.wikipedia.org/wiki/Gallium#cite_note-36) These alkylgalliums are liquids at room temperature, having low melting points, and are quite mobile and flammable. Triphenylgallium is monomeric in solution, but its crystals form chain structures due to weak intermolecluar Ga···C interactions.[[35]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood262-35)

Gallium trichloride is a common starting reagent for the formation of organogallium compounds, such as in [carbogallation](https://en.wikipedia.org/wiki/Carbometalation) reactions.[[37]](https://en.wikipedia.org/wiki/Gallium#cite_note-37) Gallium trichloride reacts with [lithium](https://en.wikipedia.org/wiki/Lithium) cyclopentadienide in [diethyl ether](https://en.wikipedia.org/wiki/Diethyl_ether) to form the trigonal planar gallium cyclopentadienyl complex GaCp3. Gallium(I) forms complexes with [arene](https://en.wikipedia.org/wiki/Arene) ligands such as [hexamethylbenzene](https://en.wikipedia.org/wiki/Hexamethylbenzene). Because this ligand is quite bulky, the structure of the [Ga(η6-C6Me6)]+ is that of a half-[sandwich](https://en.wikipedia.org/wiki/Sandwich_compound). Less bulky ligands such as [mesitylene](https://en.wikipedia.org/wiki/Mesitylene) allow two ligands to be attached to the central gallium atom in a bent sandwich structure. [Benzene](https://en.wikipedia.org/wiki/Benzene) is even less bulky and allows the formation of dimers: an example is [Ga(η6-C6H6)2] [GaCl4]·3C6H6.[[35]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood262-35)

**History**

[Play media](https://upload.wikimedia.org/wikipedia/commons/e/e4/Gallium_drops.ogv)

Small gallium droplets fusing together

In 1871, the existence of gallium was first predicted by Russian chemist [Dmitri Mendeleev](https://en.wikipedia.org/wiki/Dmitri_Mendeleev), who named it "[eka-aluminium](https://en.wikipedia.org/wiki/Mendeleev%27s_predicted_elements)" from its position in his [periodic table](https://en.wikipedia.org/wiki/Periodic_table). He also predicted several properties of eka-aluminium that correspond closely to the real properties of gallium, such as its [density](https://en.wikipedia.org/wiki/Density), [melting point](https://en.wikipedia.org/wiki/Melting_point), oxide character and bonding in chloride.[[38]](https://en.wikipedia.org/wiki/Gallium#cite_note-38)

|  |  |  |
| --- | --- | --- |
| Comparison between Mendeleev's 1871 predictions and the known properties of gallium[[39]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood217-39) | | |
| **Property** | **Mendeleev's predictions** | **Actual properties** |
| [**Atomic weight**](https://en.wikipedia.org/wiki/Atomic_weight) | ~68 | 69.723 |
| **Density** | 5.9 g/cm3 | 5.904 g/cm3 |
| **Melting point** | Low | 29.767 °C |
| **Formula of oxide** | M2O3 | Ga2O3 |
| **Density of oxide** | 5.5 g/cm3 | 5.88 g/cm3 |
| **Nature of hydroxide** | amphoteric | amphoteric |

Mendeleev further predicted that eka-aluminium would be discovered by means of the [spectroscope](https://en.wikipedia.org/wiki/Spectroscope), and that metallic eka-aluminium would dissolve slowly in both acids and alkalis and would not react with air. He also predicted that M2O3 would dissolve in acids to give MX3 salts, that eka-aluminium salts would form basic salts, that eka-aluminium sulfate should form [alums](https://en.wikipedia.org/wiki/Alum), and that anhydrous MCl3 should have a greater volatility than ZnCl2: all of these predictions turned out to be true.[[39]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood217-39)

Gallium was discovered using [spectroscopy](https://en.wikipedia.org/wiki/Spectroscopy) by French chemist [Paul Emile Lecoq de Boisbaudran](https://en.wikipedia.org/wiki/Paul_Emile_Lecoq_de_Boisbaudran) in 1875 from its characteristic spectrum (two [violet](https://en.wikipedia.org/wiki/Violet_(color)) lines) in a sample of [sphalerite](https://en.wikipedia.org/wiki/Sphalerite).[[40]](https://en.wikipedia.org/wiki/Gallium#cite_note-Bois-40) Later that year, Lecoq obtained the free metal by [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of the [hydroxide](https://en.wikipedia.org/wiki/Hydroxide) in [potassium hydroxide](https://en.wikipedia.org/wiki/Potassium_hydroxide) solution. He named the element "gallia", from [Latin](https://en.wikipedia.org/wiki/Latin) *Gallia* meaning [Gaul](https://en.wikipedia.org/wiki/Gaul), after his native land of France. It was later claimed that, in one of those multilingual [puns](https://en.wikipedia.org/wiki/Pun) so beloved by men of science in the 19th century, he had also named gallium after himself: "Le coq" is French for "the [rooster](https://en.wikipedia.org/wiki/Rooster)" and the [Latin](https://en.wikipedia.org/wiki/Latin) word for "rooster" is "*gallus*". In an 1877 article, Lecoq denied this conjecture.[[41]](https://en.wikipedia.org/wiki/Gallium#cite_note-Weeks-41) Originally, de Boisbaudran determined the density of gallium as 4.7 g/cm3, the only property that failed to match Mendeleev's predictions; Mendeleev then wrote to him and suggested that he should remeasure the density, and de Boisbaudran then obtained the correct value of 5.9 g/cm3, that Mendeleev had predicted almost exactly.[[39]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood217-39)

From its discovery in 1875 until the era of semiconductors, the primary uses of gallium were high-temperature thermometrics and metal alloys with unusual properties of stability or ease of melting (some such being liquid at room temperature). The development of [gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide) as a [direct band gap semiconductor](https://en.wikipedia.org/wiki/Direct_and_indirect_band_gaps) in the 1960s ushered in the most important stage in the applications of gallium.[[17]](https://en.wikipedia.org/wiki/Gallium#cite_note-Greenwood221-17)

**Occurrence**

Gallium does not exist as a free element in the Earth's crust, and the few high-content minerals, such as gallite (CuGaS2), are too rare to serve as a primary source.[[42]](https://en.wikipedia.org/wiki/Gallium#cite_note-:1-42) The abundance [in the Earth's crust](https://en.wikipedia.org/wiki/Earth#Chemical_composition) is approximately 16.9 [ppm](https://en.wikipedia.org/wiki/Parts_per_million).[[43]](https://en.wikipedia.org/wiki/Gallium#cite_note-Burton-43) This is comparable to the crustal abundances of [lead](https://en.wikipedia.org/wiki/Lead), [cobalt](https://en.wikipedia.org/wiki/Cobalt) and [niobium](https://en.wikipedia.org/wiki/Niobium). Yet unlike these elements, gallium does not form its own ore deposits with concentrations of > 0.1 wt.% in ore. Rather it occurs at trace concentrations similar to the crustal value in zinc ores,[[42]](https://en.wikipedia.org/wiki/Gallium#cite_note-:1-42)[[44]](https://en.wikipedia.org/wiki/Gallium#cite_note-44) and at somewhat higher values (~ 50 ppm) in aluminium ores, from both of which it is extracted as a by-product. This lack of independent deposits is due to gallium's geochemical behaviour, showing no strong enrichment in the processes relevant to the formation of most ore deposits.[[42]](https://en.wikipedia.org/wiki/Gallium#cite_note-:1-42)

The [United States Geological Survey](https://en.wikipedia.org/wiki/United_States_Geological_Survey) ([USGS](https://en.wikipedia.org/wiki/United_States_Geological_Survey)) estimates that more than 1 million tons of gallium is contained in known reserves of bauxite and zinc ores.[[45]](https://en.wikipedia.org/wiki/Gallium#cite_note-USGSCS2008-45)[[46]](https://en.wikipedia.org/wiki/Gallium#cite_note-USGSCS2006-46) Some coal [flue](https://en.wikipedia.org/wiki/Flue) [dusts](https://en.wikipedia.org/wiki/Dust) contain small quantities of gallium, typically less than 1% by weight.[[47]](https://en.wikipedia.org/wiki/Gallium#cite_note-47)[[48]](https://en.wikipedia.org/wiki/Gallium#cite_note-48)[[49]](https://en.wikipedia.org/wiki/Gallium#cite_note-49)[[50]](https://en.wikipedia.org/wiki/Gallium#cite_note-50) However, these amounts are not extractable without mining of the host materials (see below). Thus, the availability of gallium is fundamentally determined by the rate at which bauxite, zinc ores (and coal) are extracted.

**Production and availability**

[](https://en.wikipedia.org/wiki/File:6N_Gallium_sealed_in_vacuum_ampoule.jpg)

99.9999% (6N) gallium sealed in vacuum ampoule

Gallium is produced exclusively as a [by-product](https://en.wikipedia.org/wiki/By-product) during the processing of the ores of other metals. Its main source material is [bauxite](https://en.wikipedia.org/wiki/Bauxite), the chief ore of [aluminium](https://en.wikipedia.org/wiki/Aluminium), but minor amounts are also extracted from sulfidic zinc ores ([sphalerite](https://en.wikipedia.org/wiki/Sphalerite) being the main host mineral). In the past, certain coals were an important source.

During the processing of bauxite to [alumina](https://en.wikipedia.org/wiki/Aluminium_oxide) in the [Bayer process](https://en.wikipedia.org/wiki/Bayer_process), gallium accumulates in the [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide) liquor. From this it can be extracted by a variety of methods. The most recent is the use of [ion-exchange resin](https://en.wikipedia.org/wiki/Ion-exchange_resin).[[6]](https://en.wikipedia.org/wiki/Gallium#cite_note-:0-6) Achievable extraction efficiencies critically depend on the original concentration in the feed bauxite. At a typical feed concentration of 50 ppm, about 15% of the contained gallium is extractable.[[6]](https://en.wikipedia.org/wiki/Gallium#cite_note-:0-6) The remainder reports to the [red mud](https://en.wikipedia.org/wiki/Red_mud) and [aluminium hydroxide](https://en.wikipedia.org/wiki/Aluminium_hydroxide) streams. Gallium is removed from the ion-exchange resin in solution. Electrolysis then gives gallium metal. For [semiconductor](https://en.wikipedia.org/wiki/Semiconductor) use, it is further purified with [zone melting](https://en.wikipedia.org/wiki/Zone_melting) or single-crystal extraction from a melt ([Czochralski process](https://en.wikipedia.org/wiki/Czochralski_process)). Purities of 99.9999% are routinely achieved and commercially available.[[51]](https://en.wikipedia.org/wiki/Gallium#cite_note-Moskalyk-51)

[](https://en.wikipedia.org/wiki/File:Bauxite_Jamaica_1984.jpg)

Bauxite mine in [Jamaica](https://en.wikipedia.org/wiki/Jamaica) (1984).

Its by-product status means that gallium production is constrained by the amount of bauxite, sulfidic zinc ores (and coal) extracted per year. Therefore, its availability needs to be discussed in terms of supply potential. The supply potential of a by-product is defined as that amount which is economically extractable from its host materials *per year* under current market conditions (i.e. technology and price).[[52]](https://en.wikipedia.org/wiki/Gallium#cite_note-52) Reserves and resources are not relevant for by-products, since they *cannot* be extracted independently from the main-products.[[53]](https://en.wikipedia.org/wiki/Gallium#cite_note-53) Recent estimates put the supply potential of gallium at a minimum of 2,100 t/yr from bauxite, 85 t/yr from sulfidic zinc ores, and potentially 590 t/yr from coal.[[6]](https://en.wikipedia.org/wiki/Gallium#cite_note-:0-6) These figures are significantly greater than current production (375 t in 2016).[[54]](https://en.wikipedia.org/wiki/Gallium#cite_note-54) Thus, major future increases in the by-product production of gallium will be possible without significant increases in production costs or price. The average gallium price in 2015 was $US317/kg, down from $US688/kg in 2011.[[55]](https://en.wikipedia.org/wiki/Gallium#cite_note-55)

**Applications**

Semiconductor applications dominate the commercial demand for gallium, accounting for 98% of the total. The next major application is for [gadolinium gallium garnets](https://en.wikipedia.org/wiki/Gadolinium_gallium_garnet).[[56]](https://en.wikipedia.org/wiki/Gallium#cite_note-Ullmann-56)

**Semiconductors**

[](https://en.wikipedia.org/wiki/File:Blue_LED_and_Reflection.jpg)

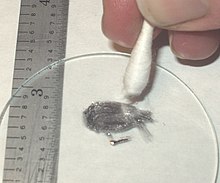
Gallium-based blue LEDs

Extremely high-purity (>99.9999%) gallium is commercially available to serve the semiconductor industry. [Gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide) (GaAs) and [gallium nitride](https://en.wikipedia.org/wiki/Gallium_nitride) (GaN) used in electronic components represented about 98% of the gallium consumption in the United States in 2007. About 66% of semiconductor gallium is used in the U.S. in integrated circuits (mostly gallium arsenide), such as the manufacture of ultra-high-speed logic chips and [MESFETs](https://en.wikipedia.org/wiki/MESFET) for low-noise microwave preamplifiers in cell phones. About 20% of this gallium is used in [optoelectronics](https://en.wikipedia.org/wiki/Optoelectronic).[[45]](https://en.wikipedia.org/wiki/Gallium#cite_note-USGSCS2008-45) Worldwide, gallium arsenide makes up 95% of the annual global gallium consumption.[[51]](https://en.wikipedia.org/wiki/Gallium#cite_note-Moskalyk-51)

Gallium arsenide is used in a variety of optoelectronic infrared devices. [Aluminium gallium arsenide](https://en.wikipedia.org/wiki/Aluminium_gallium_arsenide) (AlGaAs) is used in high-power infrared laser diodes. The semiconductors gallium nitride and [indium gallium nitride](https://en.wikipedia.org/wiki/Indium_gallium_nitride) are used in blue and violet optoelectronic devices, mostly [laser diodes](https://en.wikipedia.org/wiki/Laser_diode) and [light-emitting diodes](https://en.wikipedia.org/wiki/Light-emitting_diode). For example, gallium nitride 405 nm diode lasers are used as a violet light source for higher-density [Blu-ray Disc](https://en.wikipedia.org/wiki/Blu-ray_Disc) compact data disc drives.[[57]](https://en.wikipedia.org/wiki/Gallium#cite_note-57)

[Multijunction photovoltaic cells](https://en.wikipedia.org/wiki/Multijunction_photovoltaic_cell), developed for [satellite](https://en.wikipedia.org/wiki/Satellite) power applications, are made by [molecular-beam epitaxy](https://en.wikipedia.org/wiki/Molecular-beam_epitaxy) or [metalorganic vapour-phase epitaxy](https://en.wikipedia.org/wiki/Metalorganic_vapour-phase_epitaxy) of [thin films](https://en.wikipedia.org/wiki/Thin_film) of gallium arsenide, [indium gallium phosphide](https://en.wikipedia.org/wiki/Indium_gallium_phosphide), or [indium gallium arsenide](https://en.wikipedia.org/wiki/Indium_gallium_arsenide). The [Mars Exploration Rovers](https://en.wikipedia.org/wiki/Mars_Exploration_Rover) and several satellites use triple-junction gallium arsenide on germanium cells.[[58]](https://en.wikipedia.org/wiki/Gallium#cite_note-58) Gallium is also a component in [photovoltaic](https://en.wikipedia.org/wiki/Photovoltaic) compounds (such as copper indium gallium selenium sulfide Cu(In,Ga)(Se,S)2) used in solar panels as a cost-efficient alternative to [crystalline silicon](https://en.wikipedia.org/wiki/Crystalline_silicon).[[59]](https://en.wikipedia.org/wiki/Gallium#cite_note-59)

**Galinstan and other alloys**

[](https://en.wikipedia.org/wiki/File:Galinstan_on_glass.jpg)

Galinstan from a broken thermometer, easily wetting a piece of glass.

Gallium readily [alloys](https://en.wikipedia.org/wiki/Alloy) with most metals, and is used as an ingredient in [low-melting alloys](https://en.wikipedia.org/wiki/Low-melting_alloy). The nearly [eutectic](https://en.wikipedia.org/wiki/Eutectic) alloy of gallium, [indium](https://en.wikipedia.org/wiki/Indium), and [tin](https://en.wikipedia.org/wiki/Tin) is a room temperature liquid used in medical thermometers. This alloy, with the trade-name [*Galinstan*](https://en.wikipedia.org/wiki/Galinstan) (with the "-stan" referring to the tin, *stannum* in Latin), has a low freezing point of −19 °C (−2.2 °F).[[60]](https://en.wikipedia.org/wiki/Gallium#cite_note-60) It has been suggested that this family of alloys could also be used to cool computer chips in place of water.[[61]](https://en.wikipedia.org/wiki/Gallium#cite_note-61) Gallium alloys have been evaluated as substitutes for mercury [dental amalgams](https://en.wikipedia.org/wiki/Dental_amalgam), but these materials have yet to see wide acceptance.

Because gallium [wets](https://en.wikipedia.org/wiki/Wetting) glass or [porcelain](https://en.wikipedia.org/wiki/Porcelain), gallium can be used to create brilliant [mirrors](https://en.wikipedia.org/wiki/Mirror). When the wetting action of gallium-alloys is not desired (as in [Galinstan](https://en.wikipedia.org/wiki/Galinstan) glass thermometers), the glass must be protected with a transparent layer of [gallium(III) oxide](https://en.wikipedia.org/wiki/Gallium(III)_oxide).[[62]](https://en.wikipedia.org/wiki/Gallium#cite_note-62)

The [plutonium](https://en.wikipedia.org/wiki/Plutonium) used in [nuclear weapon pits](https://en.wikipedia.org/wiki/Plutonium_pit) is stabilized in the [δ phase](https://en.wikipedia.org/wiki/Allotropes_of_plutonium) and made machinable by [alloying with gallium](https://en.wikipedia.org/wiki/Plutonium-gallium_alloy).[[63]](https://en.wikipedia.org/wiki/Gallium#cite_note-63)

**Biomedical applications**

Although gallium has no natural function in biology, gallium ions interact with processes in the body in a manner similar to [iron(III)](https://en.wikipedia.org/wiki/Ferric#Ferric_iron_and_life). Because these processes include [inflammation](https://en.wikipedia.org/wiki/Inflammation), a marker for many disease states, several gallium salts are used (or are in development) as [pharmaceuticals](https://en.wikipedia.org/wiki/Pharmaceutical_drug) and [radiopharmaceuticals](https://en.wikipedia.org/wiki/Radiopharmacology) in medicine. Interest in the anticancer properties of gallium emerged when it was discovered that 67Ga(III) citrate injected in tumor-bearing animals localized to sites of tumor. Clinical trials have shown gallium nitrate to have antineoplastic activity against non-Hodgkin’s lymphoma and urothelial cancers. A new generation of gallium-ligand complexes such as tris(8-quinolinolato)gallium(III) (KP46) and gallium maltolate has emerged.[[64]](https://en.wikipedia.org/wiki/Gallium#cite_note-64) [Gallium nitrate](https://en.wikipedia.org/wiki/Gallium_nitrate) (brand name Ganite) has been used as an intravenous pharmaceutical to treat [hypercalcemia](https://en.wikipedia.org/wiki/Hypercalcemia) associated with tumor [metastasis](https://en.wikipedia.org/wiki/Metastasis) to bones. Gallium is thought to interfere with [osteoclast](https://en.wikipedia.org/wiki/Osteoclast) function, and the therapy may be effective when other treatments have failed.[[65]](https://en.wikipedia.org/wiki/Gallium#cite_note-65) [Gallium maltolate](https://en.wikipedia.org/wiki/Gallium_maltolate), an oral, highly absorbable form of gallium(III) ion, is an anti-proliferative to pathologically proliferating cells, particularly cancer cells and some bacteria that accept it in place of ferric iron (Fe3+). Researchers are conducting clinical and preclinical trials on this compound as a potential treatment for a number of cancers, infectious diseases, and inflammatory diseases.[[66]](https://en.wikipedia.org/wiki/Gallium#cite_note-66)

When gallium ions are mistakenly taken up in place of iron(III) by bacteria such as [*Pseudomonas*](https://en.wikipedia.org/wiki/Pseudomonas), the ions interfere with respiration, and the bacteria die. This happens because iron is redox-active, allowing the transfer of electrons during respiration, while gallium is redox-inactive.[[67]](https://en.wikipedia.org/wiki/Gallium#cite_note-67)[[68]](https://en.wikipedia.org/wiki/Gallium#cite_note-68)

A complex [amine](https://en.wikipedia.org/wiki/Amine)-[phenol](https://en.wikipedia.org/wiki/Phenol) Ga(III) compound MR045 is selectively toxic to parasites resistant to [chloroquine](https://en.wikipedia.org/wiki/Chloroquine), a common drug against [malaria](https://en.wikipedia.org/wiki/Malaria). Both the Ga(III) complex and chloroquine act by inhibiting crystallization of [hemozoin](https://en.wikipedia.org/wiki/Hemozoin), a disposal product formed from the digestion of blood by the parasites.[[69]](https://en.wikipedia.org/wiki/Gallium#cite_note-69)[[70]](https://en.wikipedia.org/wiki/Gallium#cite_note-70)

**Radiogallium salts**

[Gallium-67](https://en.wikipedia.org/wiki/Gallium-67) [salts](https://en.wikipedia.org/wiki/Salt_(chemistry)) such as gallium [citrate](https://en.wikipedia.org/wiki/Citrate) and gallium [nitrate](https://en.wikipedia.org/wiki/Nitrate) are used as [radiopharmaceutical](https://en.wikipedia.org/wiki/Radiopharmaceutical) agents in the [nuclear medicine](https://en.wikipedia.org/wiki/Nuclear_medicine) imaging known as [gallium scan](https://en.wikipedia.org/wiki/Gallium_67_scan). The [radioactive isotope](https://en.wikipedia.org/wiki/Radionuclide) 67Ga is used, and the compound or salt of gallium is unimportant. The body handles Ga3+ in many ways as though it were Fe3+, and the ion is bound (and concentrates) in areas of inflammation, such as infection, and in areas of rapid cell division. This allows such sites to be imaged by nuclear scan techniques.[[71]](https://en.wikipedia.org/wiki/Gallium#cite_note-Nordberg-71)

[Gallium-68](https://en.wikipedia.org/wiki/Gallium-68), a positron emitter with a half-life of 68 min, is now used as a diagnostic radionuclide in PET-CT when linked to pharmaceutical preparations such as [DOTATOC](https://en.wikipedia.org/wiki/DOTATOC), a [somatostatin](https://en.wikipedia.org/wiki/Somatostatin) analogue used for [neuroendocrine tumors](https://en.wikipedia.org/wiki/Neuroendocrine_tumors) investigation, and [DOTA-TATE](https://en.wikipedia.org/wiki/DOTA-TATE), a newer one, used for neuroendocrine [metastasis](https://en.wikipedia.org/wiki/Metastasis) and lung neuroendocrine cancer, such as certain types of [*microcytoma*](https://en.wikipedia.org/w/index.php?title=Microcytoma&action=edit&redlink=1). Gallium-68's preparation as a pharmaceutical is chemical, and the radionuclide is extracted by [elution](https://en.wikipedia.org/wiki/Elution) from germanium-68, a [synthetic radioisotope](https://en.wikipedia.org/wiki/Synthetic_radioisotope) of [germanium](https://en.wikipedia.org/wiki/Germanium), in [gallium-68 generators](https://en.wikipedia.org/wiki/Gallium-68_generator).[[72]](https://en.wikipedia.org/wiki/Gallium#cite_note-72)

**Other uses**

Gallium is used for [neutrino](https://en.wikipedia.org/wiki/Neutrino) detection. Possibly the largest amount of pure gallium ever collected in a single spot is the Gallium-Germanium Neutrino Telescope used by the [SAGE](https://en.wikipedia.org/wiki/SAGE_(Soviet-American_Gallium_Experiment)) experiment at the Baksan Neutrino Observatory in Russia. This detector contains 55–57 tonnes (~9 cubic metres) of liquid gallium.[[73]](https://en.wikipedia.org/wiki/Gallium#cite_note-73) Another experiment was the [GALLEX](https://en.wikipedia.org/wiki/GALLEX) neutrino detector operated in the early 1990s in an Italian mountain tunnel. The detector contained 12.2 tons of watered gallium-71. Solar neutrinos caused a few atoms of 71Ga to become radioactive 71[Ge](https://en.wikipedia.org/wiki/Germanium), which were detected. This experiment showed that the solar neutrino flux is 40% less than theory predicted. This deficit was not explained until better solar neutrino detectors and theories were constructed (see [SNO](https://en.wikipedia.org/wiki/Sudbury_Neutrino_Observatory)).[[74]](https://en.wikipedia.org/wiki/Gallium#cite_note-74)

Gallium is also used as a [liquid metal ion source](https://en.wikipedia.org/wiki/Liquid_metal_ion_source) for a [focused ion beam](https://en.wikipedia.org/wiki/Focused_ion_beam). For example, a focused gallium-ion beam was used to create the world's smallest book, [*Teeny Ted from Turnip Town*](https://en.wikipedia.org/wiki/Teeny_Ted_from_Turnip_Town).[[75]](https://en.wikipedia.org/wiki/Gallium#cite_note-pr-75) Another use of gallium is as an additive in glide wax for skis, and other low-friction surface materials.[[76]](https://en.wikipedia.org/wiki/Gallium#cite_note-76)

A well-known [practical joke](https://en.wikipedia.org/wiki/Practical_joke) among chemists is to fashion gallium spoons and use them to serve tea to unsuspecting guests, since gallium has a similar appearance to its lighter homolog aluminium. The spoons then melt in the hot tea.[[77]](https://en.wikipedia.org/wiki/Gallium#cite_note-Sam_Kean2010-77)

|  |  |
| --- | --- |
| Gallium | |
| **Hazards** | |
| [GHS pictograms](https://en.wikipedia.org/wiki/GHS_hazard_pictograms) | [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) | H290, H318 |
| [GHS precautionary statements](https://en.wikipedia.org/wiki/GHS_precautionary_statements) | P280, P305, P351, P338, P310[[78]](https://en.wikipedia.org/wiki/Gallium#cite_note-78) |
| [NFPA 704](https://en.wikipedia.org/wiki/NFPA_704) | [[79]](https://en.wikipedia.org/wiki/Gallium#cite_note-79)  NFPA 704 four-colored diamond  [0](https://en.wikipedia.org/wiki/NFPA_704#Red)  [2](https://en.wikipedia.org/wiki/NFPA_704#Blue)  [0](https://en.wikipedia.org/wiki/NFPA_704#Yellow) |

**Precautions**

Metallic gallium is not toxic. However, exposure to gallium halide complexes can result in acute toxicity.[[80]](https://en.wikipedia.org/wiki/Gallium#cite_note-80) The Ga3+ ion of soluble gallium salts tends to form the insoluble hydroxide when injected in large doses; precipitation of this hydroxide resulted in [renal](https://en.wikipedia.org/wiki/Renal) toxicity in animals. In lower doses, soluble gallium is tolerated well and does not accumulate as a poison, instead being excreted mostly through urine. Excretion of gallium occurs in two phases: the first phase has a [biological half-life](https://en.wikipedia.org/wiki/Biological_half-life) of 1 hour, while the second has a biological half-life of 25 hours.[[71]](https://en.wikipedia.org/wiki/Gallium#cite_note-Nordberg-71)

**See also**

|  |  |
| --- | --- |
| [**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[***Gallium***](https://en.wikipedia.org/wiki/Book:Gallium) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Period 4 elements***](https://en.wikipedia.org/wiki/Book:Period_4_elements) * https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Office-book.svg/30px-Office-book.svg.png[***Boron group***](https://en.wikipedia.org/wiki/Book:Boron_group) * 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/Gallium) 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/gallium#English) from Wiktionary * 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/Gallium_atom) from Wikiversity |

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