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**Yttrium**

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Not to be confused with element [ytterbium](https://en.wikipedia.org/wiki/Ytterbium) *(Yb)*.

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| --- | --- |
| Yttrium,  39Y | |
| [Yttrium sublimed dendritic and 1cm3 cube.jpg](https://en.wikipedia.org/wiki/File:Yttrium_sublimed_dendritic_and_1cm3_cube.jpg) | |
| **General properties** | |
| **Pronunciation** | [/ˈɪtriəm/](https://en.wikipedia.org/wiki/Help:IPA/English) ​([*IT-ree-əm*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key)) |
| **Appearance** | silvery white |
| [**Standard atomic weight**](https://en.wikipedia.org/wiki/Standard_atomic_weight) **(*A*r, standard)** | 88.90584(1)[[1]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CIAAW2016-1) |
| **Yttrium 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](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 |  |  | | | | | | | | | | | | | [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) | | [Sc](https://en.wikipedia.org/wiki/Scandium) ↑ **Y** ↓ [La](https://en.wikipedia.org/wiki/Lanthanum) | | [strontium](https://en.wikipedia.org/wiki/Strontium) ← **yttrium** → [zirconium](https://en.wikipedia.org/wiki/Zirconium) | | | | |
| [**Atomic number**](https://en.wikipedia.org/wiki/Atomic_number)(*Z*) | 39 |
| [**Group**](https://en.wikipedia.org/wiki/Group_(periodic_table)) | [group 3](https://en.wikipedia.org/wiki/Group_3_element) |
| [**Period**](https://en.wikipedia.org/wiki/Period_(periodic_table)) | [period 5](https://en.wikipedia.org/wiki/Period_(periodic_table)#Period_5) |
| [**Block**](https://en.wikipedia.org/wiki/Block_(periodic_table)) | [d-block](https://en.wikipedia.org/wiki/D-block) |
| [**Element category**](https://en.wikipedia.org/wiki/Names_for_sets_of_chemical_elements#Category) | [transition metal](https://en.wikipedia.org/wiki/Transition_metal) |
| [**Electron configuration**](https://en.wikipedia.org/wiki/Electron_configuration) | [[Kr](https://en.wikipedia.org/wiki/Krypton)] 4d1 5s2 |
| Electrons per shell | 2, 8, 18, 9, 2 |
| **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) | 1799 [K](https://en.wikipedia.org/wiki/Kelvin) ​(1526 °C, ​2779 °F) |
| [**Boiling point**](https://en.wikipedia.org/wiki/Boiling_point) | 3203 K ​(2930 °C, ​5306 °F) |
| [**Density**](https://en.wikipedia.org/wiki/Density)(near r.t.) | 4.472 g/cm3 |
| when liquid (at m.p.) | 4.24 g/cm3 |
| [**Heat of fusion**](https://en.wikipedia.org/wiki/Enthalpy_of_fusion) | 11.42 [kJ/mol](https://en.wikipedia.org/wiki/Kilojoule_per_mole) |
| [**Heat of vaporization**](https://en.wikipedia.org/wiki/Enthalpy_of_vaporization) | 363 kJ/mol |
| [**Molar heat capacity**](https://en.wikipedia.org/wiki/Molar_heat_capacity) | 26.53 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) | 1883 | 2075 | (2320) | (2627) | (3036) | (3607) | | |
| **Atomic properties** | |
| [**Oxidation states**](https://en.wikipedia.org/wiki/Oxidation_state) | +1, +2, **+3** (a weakly [basic](https://en.wikipedia.org/wiki/Base_(chemistry)) oxide) |
| [**Electronegativity**](https://en.wikipedia.org/wiki/Electronegativity) | Pauling scale: 1.22 |
| [**Ionization energies**](https://en.wikipedia.org/wiki/Ionization_energy) | * 1st: 600 kJ/mol * 2nd: 1180 kJ/mol * 3rd: 1980 kJ/mol |
| [**Atomic radius**](https://en.wikipedia.org/wiki/Atomic_radius) | empirical: 180 [pm](https://en.wikipedia.org/wiki/Picometre) |
| [**Covalent radius**](https://en.wikipedia.org/wiki/Covalent_radius) | 190±7 pm |
| [Color lines in a spectral range](https://en.wikipedia.org/wiki/File:Yttrium_spectrum_visible.png)  [**Spectral lines**](https://en.wikipedia.org/wiki/Spectral_line) **of yttrium** | |
| **Other properties** | |
| [**Crystal structure**](https://en.wikipedia.org/wiki/Crystal_structure) | ​[hexagonal close-packed](https://en.wikipedia.org/wiki/Close-packing_of_equal_spheres) (hcp)  [Hexagonal close packed crystal structure for yttrium](https://en.wikipedia.org/wiki/File:Hexagonal_close_packed.svg) |
| [**Speed of sound**](https://en.wikipedia.org/wiki/Speed_of_sound)thin rod | 3300 m/s (at 20 °C) |
| [**Thermal expansion**](https://en.wikipedia.org/wiki/Coefficient_of_thermal_expansion) | α, poly: 10.6 µm/(m·K) (at r.t.) |
| [**Thermal conductivity**](https://en.wikipedia.org/wiki/Thermal_conductivity) | 17.2 W/(m·K) |
| [**Electrical resistivity**](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) | α, poly: 596 nΩ·m (at r.t.) |
| [**Magnetic ordering**](https://en.wikipedia.org/wiki/Magnetism) | [paramagnetic](https://en.wikipedia.org/wiki/Paramagnetic)[[2]](https://en.wikipedia.org/wiki/Yttrium#cite_note-magnet-2) |
| [**Magnetic susceptibility**](https://en.wikipedia.org/wiki/Magnetic_susceptibility) | +2.15·10−6 cm3/mol (2928 K)[[3]](https://en.wikipedia.org/wiki/Yttrium#cite_note-3) |
| [**Young's modulus**](https://en.wikipedia.org/wiki/Young%27s_modulus) | 63.5 GPa |
| [**Shear modulus**](https://en.wikipedia.org/wiki/Shear_modulus) | 25.6 GPa |
| [**Bulk modulus**](https://en.wikipedia.org/wiki/Bulk_modulus) | 41.2 GPa |
| [**Poisson ratio**](https://en.wikipedia.org/wiki/Poisson%27s_ratio) | 0.243 |
| [**Brinell hardness**](https://en.wikipedia.org/wiki/Brinell_hardness_test) | 200–589 MPa |
| [**CAS Number**](https://en.wikipedia.org/wiki/CAS_Registry_Number) | 7440-65-5 |
| **History** | |
| **Naming** | after [Ytterby](https://en.wikipedia.org/wiki/Ytterby) (Sweden) and its mineral [ytterbite](https://en.wikipedia.org/wiki/Ytterbite) (gadolinite) |
| [**Discovery**](https://en.wikipedia.org/wiki/Timeline_of_chemical_element_discoveries) | [Johan Gadolin](https://en.wikipedia.org/wiki/Johan_Gadolin) (1794) |
| **First isolation** | [Heinrich Rose](https://en.wikipedia.org/wiki/Heinrich_Rose) (1843) |
| **Main** [**isotopes of yttrium**](https://en.wikipedia.org/wiki/Isotopes_of_yttrium) | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | [**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) | | **87Y** | [syn](https://en.wikipedia.org/wiki/Synthetic_radioisotope) | 3.4 d | [ε](https://en.wikipedia.org/wiki/Electron_capture) | [87Sr](https://en.wikipedia.org/wiki/Strontium-87) | | [γ](https://en.wikipedia.org/wiki/Gamma_radiation) | – | | **88Y** | syn | 106.6 d | ε | [88Sr](https://en.wikipedia.org/wiki/Strontium-88) | | γ | – | | **89Y** | 100% | [stable](https://en.wikipedia.org/wiki/Stable_isotope) | | | | **90Y** | syn | 2.7 d | [β−](https://en.wikipedia.org/wiki/Beta_decay) | [90Zr](https://en.wikipedia.org/wiki/Zirconium-90) | | γ | – | | **91Y** | syn | 58.5 d | β− | [91Zr](https://en.wikipedia.org/wiki/Zirconium-91) | | γ | – | | |
| * [view](https://en.wikipedia.org/wiki/Template:Infobox_yttrium) * [talk](https://en.wikipedia.org/wiki/Template_talk:Infobox_yttrium) * [edit](https://en.wikipedia.org/w/index.php?title=Template:Infobox_yttrium&action=edit)   | [references](https://en.wikipedia.org/wiki/List_of_data_references_for_chemical_elements) | |

**Yttrium** is a [chemical element](https://en.wikipedia.org/wiki/Chemical_element) with symbol **Y** and [atomic number](https://en.wikipedia.org/wiki/Atomic_number) 39. It is a silvery-metallic [transition metal](https://en.wikipedia.org/wiki/Transition_metal) chemically similar to the [lanthanides](https://en.wikipedia.org/wiki/Lanthanide) and has often been classified as a "[rare-earth element](https://en.wikipedia.org/wiki/Rare-earth_element)".[[4]](https://en.wikipedia.org/wiki/Yttrium#cite_note-IUPAC1-4) Yttrium is almost always found in combination with lanthanide elements in [rare-earth minerals](https://en.wikipedia.org/wiki/Rare-earth_mineral), and is never found in nature as a free element. 89Y is the only stable [isotope](https://en.wikipedia.org/wiki/Isotope), and the only isotope found in the [Earth's crust](https://en.wikipedia.org/wiki/Crust_(geology)).

In 1787, [Carl Axel Arrhenius](https://en.wikipedia.org/wiki/Carl_Axel_Arrhenius) found a new mineral near [Ytterby](https://en.wikipedia.org/wiki/Ytterby) in [Sweden](https://en.wikipedia.org/wiki/Sweden) and named it [*ytterbite*](https://en.wikipedia.org/wiki/Gadolinite), after the village. [Johan Gadolin](https://en.wikipedia.org/wiki/Johan_Gadolin) discovered yttrium's oxide in Arrhenius' sample in 1789,[[5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Krogt-5) and [Anders Gustaf Ekeberg](https://en.wikipedia.org/wiki/Anders_Gustaf_Ekeberg) named the new [oxide](https://en.wikipedia.org/wiki/Oxide) [*yttria*](https://en.wikipedia.org/wiki/Yttria). Elemental yttrium was first isolated in 1828 by [Friedrich Wöhler](https://en.wikipedia.org/wiki/Friedrich_W%C3%B6hler).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6)

The most important uses of yttrium are [LEDs](https://en.wikipedia.org/wiki/LED) and [phosphors](https://en.wikipedia.org/wiki/Phosphor), particularly the red phosphors in television set [cathode ray tube](https://en.wikipedia.org/wiki/Cathode_ray_tube) (CRT) displays.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7) Yttrium is also used in the production of [electrodes](https://en.wikipedia.org/wiki/Electrode), [electrolytes](https://en.wikipedia.org/wiki/Electrolyte), [electronic filters](https://en.wikipedia.org/wiki/Electronic_filters), [lasers](https://en.wikipedia.org/wiki/Laser), [superconductors](https://en.wikipedia.org/wiki/Superconductor), various medical applications, and [tracing](https://en.wikipedia.org/wiki/Trace_element) various materials to enhance their properties.

Yttrium has no known [biological](https://en.wikipedia.org/wiki/Biology) role. Exposure to yttrium compounds can cause [lung disease](https://en.wikipedia.org/wiki/Respiratory_disease) in humans.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8)



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* [11 External links](https://en.wikipedia.org/wiki/Yttrium#External_links)

**Characteristics**

**Properties**

Yttrium is a soft, silver-metallic, lustrous and highly crystalline [transition metal](https://en.wikipedia.org/wiki/Transition_metal) in [group 3](https://en.wikipedia.org/wiki/Group_3_element). As expected by [periodic trends](https://en.wikipedia.org/wiki/Periodic_trend), it is less [electronegative](https://en.wikipedia.org/wiki/Electronegativity) than its predecessor in the group, [scandium](https://en.wikipedia.org/wiki/Scandium), and less electronegative than the next member of [period 5](https://en.wikipedia.org/wiki/Period_5_element), [zirconium](https://en.wikipedia.org/wiki/Zirconium); additionally, it is more electronegative to its successor in its group, [lanthanum](https://en.wikipedia.org/wiki/Lanthanum), being closer in electronegativity to the later [lanthanides](https://en.wikipedia.org/wiki/Lanthanide) due to the [lanthanide contraction](https://en.wikipedia.org/wiki/Lanthanide_contraction).[[9]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p946-9)[[10]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Hammond-10) Yttrium is the first [d-block](https://en.wikipedia.org/wiki/D-block) element in the fifth period.

The pure element is relatively stable in air in bulk form, due to [passivation](https://en.wikipedia.org/wiki/Passivation_(chemistry)) of a protective oxide (Y  
2O  
3) film that forms on the surface. This film can reach a thickness of 10 [µm](https://en.wikipedia.org/wiki/Micrometre) when yttrium is heated to 750 °[C](https://en.wikipedia.org/wiki/Celsius) in [water vapor](https://en.wikipedia.org/wiki/Water_vapor).[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11) When finely divided, however, yttrium is very unstable in air; shavings or [turnings](https://en.wikipedia.org/wiki/Swarf) of the metal can ignite in air at temperatures exceeding 400 °C.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) [Yttrium nitride](https://en.wikipedia.org/wiki/Yttrium_nitride) (YN) is formed when the metal is heated to 1000 °C in [nitrogen](https://en.wikipedia.org/wiki/Nitrogen).[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

**Similarity to the lanthanides**

Further information: [Rare-earth element](https://en.wikipedia.org/wiki/Rare-earth_element)

The similarities of yttrium to the [lanthanides](https://en.wikipedia.org/wiki/Lanthanide) are so strong that the element has historically been grouped with them as a [rare-earth element](https://en.wikipedia.org/wiki/Rare-earth_element),[[4]](https://en.wikipedia.org/wiki/Yttrium#cite_note-IUPAC1-4) and is always found in nature together with them in [rare-earth minerals](https://en.wikipedia.org/wiki/Rare-earth_mineral).[[12]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley498-12) Chemically, yttrium resembles those elements more closely than its neighbor in the periodic table, [scandium](https://en.wikipedia.org/wiki/Scandium),[[13]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE810-13) and if physical properties were plotted against [atomic number](https://en.wikipedia.org/wiki/Atomic_number), it would have an apparent number of 64.5 to 67.5, placing it between the lanthanides [gadolinium](https://en.wikipedia.org/wiki/Gadolinium) and [erbium](https://en.wikipedia.org/wiki/Erbium).[[14]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE815-14)

It often also falls in the same range for reaction order,[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11) resembling [terbium](https://en.wikipedia.org/wiki/Terbium) and [dysprosium](https://en.wikipedia.org/wiki/Dysprosium) in its chemical reactivity.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7) Yttrium is so close in size to the so-called 'yttrium group' of heavy lanthanide ions that in solution, it behaves as if it were one of them.[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)[[15]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p945-15) Even though the lanthanides are one row farther down the periodic table than yttrium, the similarity in atomic radius may be attributed to the [lanthanide contraction](https://en.wikipedia.org/wiki/Lanthanide_contraction).[[16]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p1234-16)

One of the few notable differences between the chemistry of yttrium and that of the lanthanides is that yttrium is almost exclusively [trivalent](https://en.wikipedia.org/wiki/Valency_(chemistry)), whereas about half the lanthanides can have valences other than three; nevertheless, only for four of the fifteen lanthanides are these other valences important in aqueous solution ([CeIV](https://en.wikipedia.org/wiki/Cerium), [SmII](https://en.wikipedia.org/wiki/Samarium), [EuII](https://en.wikipedia.org/wiki/Europium), and [YbII](https://en.wikipedia.org/wiki/Ytterbium)).[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

**Compounds and reactions**

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

[](https://en.wikipedia.org/wiki/File:Yttrium_%2B_carbonate.jpg)

Left: Soluble yttrium salts reacts with carbonate, forming white precipitate yttrium carbonate. Right: Yttrium carbonate is soluble in excess alkali metal carbonate solution

As a trivalent transition metal, yttrium forms various [inorganic compounds](https://en.wikipedia.org/wiki/Inorganic_chemistry), generally in the oxidation state of +3, by giving up all three of its [valence electrons](https://en.wikipedia.org/wiki/Valence_electron).[[17]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p948-17) A good example is [yttrium(III) oxide](https://en.wikipedia.org/wiki/Yttrium(III)_oxide) (Y  
2O  
3), also known as yttria, a six-[coordinate](https://en.wikipedia.org/wiki/Coordinate_covalent_bond) white solid.[[18]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p947-18)

Yttrium forms a water-insoluble [fluoride](https://en.wikipedia.org/wiki/Fluoride), [hydroxide](https://en.wikipedia.org/wiki/Hydroxide), and [oxalate](https://en.wikipedia.org/wiki/Oxalate), but its [bromide](https://en.wikipedia.org/wiki/Bromide), [chloride](https://en.wikipedia.org/wiki/Chloride), [iodide](https://en.wikipedia.org/wiki/Iodide), [nitrate](https://en.wikipedia.org/wiki/Nitrate) and [sulfate](https://en.wikipedia.org/wiki/Sulfate) are all [soluble](https://en.wikipedia.org/wiki/Solubility) in water.[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11) The Y3+ [ion](https://en.wikipedia.org/wiki/Ion) is colorless in solution because of the absence of electrons in the d and f [electron shells](https://en.wikipedia.org/wiki/Electron_shell).[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

[Water](https://en.wikipedia.org/wiki/Water) readily reacts with yttrium and its compounds to form Y  
2O  
3.[[12]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley498-12) Concentrated [nitric](https://en.wikipedia.org/wiki/Nitric_acid) and [hydrofluoric acids](https://en.wikipedia.org/wiki/Hydrofluoric_acid) do not rapidly attack yttrium, but other strong acids do.[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

With [halogens](https://en.wikipedia.org/wiki/Halogen), yttrium forms [trihalides](https://en.wikipedia.org/wiki/Halide) such as [yttrium(III) fluoride](https://en.wikipedia.org/wiki/Yttrium(III)_fluoride) (YF  
3), [yttrium(III) chloride](https://en.wikipedia.org/wiki/Yttrium(III)_chloride) (YCl  
3), and [yttrium(III) bromide](https://en.wikipedia.org/wiki/Yttrium(III)_bromide) (YBr  
3) at temperatures above roughly 200 °C.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8) Similarly, [carbon](https://en.wikipedia.org/wiki/Carbon), [phosphorus](https://en.wikipedia.org/wiki/Phosphorus), [selenium](https://en.wikipedia.org/wiki/Selenium), [silicon](https://en.wikipedia.org/wiki/Silicon) and [sulfur](https://en.wikipedia.org/wiki/Sulfur) all form [binary compounds](https://en.wikipedia.org/wiki/Binary_compound) with yttrium at elevated temperatures.[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

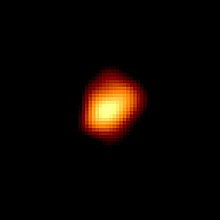
[Organoyttrium chemistry](https://en.wikipedia.org/wiki/Organoyttrium_chemistry) is the study of compounds containing carbon–yttrium bonds. A few of these are known to have yttrium in the oxidation state 0.[[19]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cloke1993-19)[[20]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Schumann-20) (The +2 state has been observed in chloride melts,[[21]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Mikheev1992-21) and +1 in oxide clusters in the gas phase.[[22]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Kang2005-22)) Some [trimerization](https://en.wikipedia.org/wiki/Trimerization) reactions were generated with organoyttrium compounds as catalysts.[[20]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Schumann-20) These syntheses use YCl  
3 as a starting material, obtained from Y  
2O  
3 and concentrated [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) and [ammonium chloride](https://en.wikipedia.org/wiki/Ammonium_chloride).[[23]](https://en.wikipedia.org/wiki/Yttrium#cite_note-23)[[24]](https://en.wikipedia.org/wiki/Yttrium#cite_note-24)

[Hapticity](https://en.wikipedia.org/wiki/Hapticity) is a term to describe the coordination of a group of contiguous atoms of a [ligand](https://en.wikipedia.org/wiki/Ligand) bound to the central atom; it is indicated by the Greek character *eta*, η. Yttrium complexes were the first examples of complexes where [carboranyl](https://en.wikipedia.org/wiki/Carborane) ligands were bound to a d0-metal center through a η7-hapticity.[[20]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Schumann-20) Vaporization of the [graphite intercalation compounds](https://en.wikipedia.org/wiki/Graphite_intercalation_compound) graphite–Y or graphite–Y  
2O  
3 leads to the formation of [endohedral fullerenes](https://en.wikipedia.org/wiki/Endohedral_fullerene) such as Y@C82.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7) [Electron spin resonance](https://en.wikipedia.org/wiki/Electron_spin_resonance) studies indicated the formation of Y3+ and (C82)3− ion pairs.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7) The [carbides](https://en.wikipedia.org/wiki/Carbide) Y3C, Y2C, and YC2 can be hydrolyzed to form [hydrocarbons](https://en.wikipedia.org/wiki/Hydrocarbon).[[11]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE817-11)

**Isotopes and nucleosynthesis**

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

Yttrium in the [Solar System](https://en.wikipedia.org/wiki/Solar_System) was created through [stellar nucleosynthesis](https://en.wikipedia.org/wiki/Stellar_nucleosynthesis), mostly by the [s-process](https://en.wikipedia.org/wiki/S-process) (≈72%), but also by the [r-process](https://en.wikipedia.org/wiki/R-process) (≈28%).[[25]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Pack-25) The r-process consists of rapid [neutron capture](https://en.wikipedia.org/wiki/Neutron_capture) of lighter elements during [supernova](https://en.wikipedia.org/wiki/Supernova) explosions. The s-process is a slow [neutron](https://en.wikipedia.org/wiki/Neutron) capture of lighter elements inside pulsating [red giant](https://en.wikipedia.org/wiki/Red_giant) stars.[[26]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p12-13-26)

[](https://en.wikipedia.org/wiki/File:Mira_1997.jpg)

[Mira](https://en.wikipedia.org/wiki/Mira) is an example of the type of red giant star where most of the yttrium in the solar system was created

Yttrium isotopes are among the most common products of the [nuclear fission](https://en.wikipedia.org/wiki/Nuclear_fission) of uranium in nuclear explosions and nuclear reactors. In the context of [nuclear waste](https://en.wikipedia.org/wiki/Nuclear_waste) management, the most important isotopes of yttrium are 91Y and 90Y, with half-lives of 58.51 days and 64 hours, respectively.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) Though 90Y has a short half-life, it exists in [secular equilibrium](https://en.wikipedia.org/wiki/Secular_equilibrium) with its long-lived parent isotope, [strontium-90](https://en.wikipedia.org/wiki/Strontium-90) (90Sr) with a half-life of 29 years.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6)

All group 3 elements have an odd [atomic number](https://en.wikipedia.org/wiki/Atomic_number), and therefore few stable [isotopes](https://en.wikipedia.org/wiki/Isotope).[[9]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p946-9) [Scandium](https://en.wikipedia.org/wiki/Scandium) has one [stable isotope](https://en.wikipedia.org/wiki/Stable_isotope), and yttrium itself has only one stable isotope, 89Y, which is also the only isotope that occurs naturally. However, the lanthanide [rare earths](https://en.wikipedia.org/wiki/Rare_earths) contain elements of even atomic number and many stable isotopes. Yttrium-89 is thought to be more abundant than it otherwise would be, due in part to the s-process, which allows enough time for isotopes created by other processes to decay by [electron emission](https://en.wikipedia.org/wiki/Beta_decay) (neutron → proton).[[26]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p12-13-26)[[note 1]](https://en.wikipedia.org/wiki/Yttrium#cite_note-28) Such a slow process tends to favor isotopes with [atomic mass numbers](https://en.wikipedia.org/wiki/Atomic_mass_number) (A = protons + neutrons) around 90, 138 and 208, which have unusually stable [atomic nuclei](https://en.wikipedia.org/wiki/Atomic_nucleus) with 50, 82, and 126 neutrons, respectively.[[26]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p12-13-26)[[note 2]](https://en.wikipedia.org/wiki/Yttrium#cite_note-29)[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) 89Y has a mass number close to 90 and has 50 neutrons in its nucleus.

At least 32 synthetic isotopes of yttrium have been observed, and these range in [atomic mass number](https://en.wikipedia.org/wiki/Atomic_mass_number) from 76 to 108.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) The least stable of these is 106Y with a [half-life](https://en.wikipedia.org/wiki/Half-life) of >150 [ns](https://en.wikipedia.org/wiki/SI_prefix) (76Y has a half-life of >200 ns) and the most stable is 88Y with a half-life of 106.626 days.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) Apart from the isotopes 91Y, 87Y, and 90Y, with half-lives of 58.51 days, 79.8 hours, and 64 hours, respectively, all the other isotopes have half-lives of less than a day and most of less than an hour.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27)

Yttrium isotopes with mass numbers at or below 88 decay primarily by [positron emission](https://en.wikipedia.org/wiki/Positron_emission) (proton → neutron) to form [strontium](https://en.wikipedia.org/wiki/Strontium) ([Z](https://en.wikipedia.org/wiki/Atomic_number) = 38) isotopes.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) Yttrium isotopes with mass numbers at or above 90 decay primarily by electron emission (neutron → proton) to form [zirconium](https://en.wikipedia.org/wiki/Zirconium) (Z = 40) isotopes.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) Isotopes with mass numbers at or above 97 are also known to have minor decay paths of β− delayed [neutron emission](https://en.wikipedia.org/wiki/Neutron_emission).[[28]](https://en.wikipedia.org/wiki/Yttrium#cite_note-nubase-30)

Yttrium has at least 20 [metastable ("excited") isomers](https://en.wikipedia.org/wiki/Metastable_isomer) ranging in mass number from 78 to 102.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27)[[note 3]](https://en.wikipedia.org/wiki/Yttrium#cite_note-31) Multiple excitation states have been observed for 80Y and 97Y.[[27]](https://en.wikipedia.org/wiki/Yttrium#cite_note-NNDC-27) While most of yttrium's isomers are expected to be less stable than their [ground state](https://en.wikipedia.org/wiki/Ground_state), 78mY, 84mY, 85mY, 96mY, 98m1Y, 100mY, and 102mY have longer half-lives than their ground states, as these isomers decay by beta decay rather than [isomeric transition](https://en.wikipedia.org/wiki/Isomeric_transition).[[28]](https://en.wikipedia.org/wiki/Yttrium#cite_note-nubase-30)

**History**

In 1787, army lieutenant and part-time chemist [Carl Axel Arrhenius](https://en.wikipedia.org/wiki/Carl_Axel_Arrhenius) found a heavy black rock in an old quarry near the Swedish village of [Ytterby](https://en.wikipedia.org/wiki/Ytterby) (now part of the [Stockholm Archipelago](https://en.wikipedia.org/wiki/Stockholm_Archipelago)).[[5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Krogt-5) Thinking that it was an unknown mineral containing the newly discovered element [tungsten](https://en.wikipedia.org/wiki/Tungsten),[[29]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley496-32) he named it *ytterbite*[[note 4]](https://en.wikipedia.org/wiki/Yttrium#cite_note-33) and sent samples to various chemists for analysis.[[5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Krogt-5)

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

[Johan Gadolin](https://en.wikipedia.org/wiki/Johan_Gadolin) discovered yttrium oxide

[Johan Gadolin](https://en.wikipedia.org/wiki/Johan_Gadolin) at the [University of Åbo](https://en.wikipedia.org/wiki/University_of_%C3%85bo) identified a new oxide (or "[earth](https://en.wikipedia.org/wiki/Earth_(chemistry))") in Arrhenius' sample in 1789, and published his completed analysis in 1794.[[30]](https://en.wikipedia.org/wiki/Yttrium#cite_note-34)[[note 5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-35) [Anders Gustaf Ekeberg](https://en.wikipedia.org/wiki/Anders_Gustaf_Ekeberg) confirmed the identification in 1797 and named the new oxide *yttria*.[[31]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Greenwood1997p944-36) In the decades after [Antoine Lavoisier](https://en.wikipedia.org/wiki/Antoine_Lavoisier) developed the first modern definition of [chemical elements](https://en.wikipedia.org/wiki/Chemical_element), it was believed that earths could be reduced to their elements, meaning that the discovery of a new earth was equivalent to the discovery of the element within, which in this case would have been *yttrium*.[[note 6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-37)

In 1843, [Carl Gustaf Mosander](https://en.wikipedia.org/wiki/Carl_Gustaf_Mosander) found that samples of yttria contained three oxides: white [yttrium oxide](https://en.wikipedia.org/wiki/Yttrium_oxide) (yttria), yellow [terbium oxide](https://en.wikipedia.org/wiki/Terbium(III,IV)_oxide) (confusingly, this was called 'erbia' at the time) and rose-colored [erbium oxide](https://en.wikipedia.org/wiki/Erbium_oxide) (called 'terbia' at the time).[[32]](https://en.wikipedia.org/wiki/Yttrium#cite_note-38) A fourth oxide, [ytterbium oxide](https://en.wikipedia.org/wiki/Ytterbium_oxide), was isolated in 1878 by [Jean Charles Galissard de Marignac](https://en.wikipedia.org/wiki/Jean_Charles_Galissard_de_Marignac).[[33]](https://en.wikipedia.org/wiki/Yttrium#cite_note-39) New elements were later isolated from each of those oxides, and each element was named, in some fashion, after Ytterby, the village near the quarry where they were found (see [ytterbium](https://en.wikipedia.org/wiki/Ytterbium), [terbium](https://en.wikipedia.org/wiki/Terbium), and [erbium](https://en.wikipedia.org/wiki/Erbium)).[[34]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Stwertka115-40) In the following decades, seven other new metals were discovered in "Gadolin's yttria".[[5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Krogt-5) Since yttria was found to be a mineral and not an oxide, [Martin Heinrich Klaproth](https://en.wikipedia.org/wiki/Martin_Heinrich_Klaproth) renamed it [gadolinite](https://en.wikipedia.org/wiki/Gadolinite) in honor of Gadolin.[[5]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Krogt-5)

[Friedrich Wöhler](https://en.wikipedia.org/wiki/Friedrich_W%C3%B6hler) mistakenly thought he had isolated the metal in 1828 from a volatile chloride he supposed to be yttrium chloride,[[35]](https://en.wikipedia.org/wiki/Yttrium#cite_note-41)[[36]](https://en.wikipedia.org/wiki/Yttrium#cite_note-42) but [Heinrich Rose](https://en.wikipedia.org/wiki/Heinrich_Rose) proved otherwise in 1843 and correctly isolated the element himself that year.

Until the early 1920s, the chemical symbol **Yt** was used for the element, after which **Y** came into common use.[[37]](https://en.wikipedia.org/wiki/Yttrium#cite_note-43)

In 1987, [yttrium barium copper oxide](https://en.wikipedia.org/wiki/Yttrium_barium_copper_oxide) was found to achieve [high-temperature superconductivity](https://en.wikipedia.org/wiki/High-temperature_superconductivity).[[38]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Wu-44) It was only the second material known to exhibit this property,[[38]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Wu-44) and it was the first known material to achieve [superconductivity](https://en.wikipedia.org/wiki/Superconductivity) above the (economically important) boiling point of nitrogen.[[note 7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-45)

**Occurrence**

[](https://en.wikipedia.org/wiki/File:Xenot%C3%ADmio1.jpeg)

[Xenotime](https://en.wikipedia.org/wiki/Xenotime) crystals contain yttrium

**Abundance**

Yttrium is found in most [rare-earth minerals](https://en.wikipedia.org/wiki/Rare-earth_mineral),[[10]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Hammond-10) it is found in some [uranium](https://en.wikipedia.org/wiki/Uranium) ores, but is never found in the Earth's crust as a free element.[[39]](https://en.wikipedia.org/wiki/Yttrium#cite_note-46) About 31 [ppm](https://en.wikipedia.org/wiki/Parts_per_million) of the Earth's crust is yttrium,[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7) making it the 28th most abundant element, 400 times more common than [silver](https://en.wikipedia.org/wiki/Silver).[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47) Yttrium is found in soil in concentrations between 10 and 150 ppm (dry weight average of 23 ppm) and in sea water at 9 [ppt](https://en.wikipedia.org/wiki/Parts_per_trillion).[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47) Lunar rock samples collected during the [American](https://en.wikipedia.org/wiki/United_States) [Apollo Project](https://en.wikipedia.org/wiki/Apollo_Project) have a relatively high content of yttrium.[[34]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Stwertka115-40)

Yttrium has no known biological role, though it is found in most, if not all, organisms and tends to concentrate in the liver, kidney, spleen, lungs, and bones of humans.[[41]](https://en.wikipedia.org/wiki/Yttrium#cite_note-48) Normally, as little as 0.5 milligrams is found in the entire human body; human [breast milk](https://en.wikipedia.org/wiki/Breast_milk) contains 4 ppm.[[42]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley495-49) Yttrium can be found in edible plants in concentrations between 20 ppm and 100 ppm (fresh weight), with [cabbage](https://en.wikipedia.org/wiki/Cabbage) having the largest amount.[[42]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley495-49) With as much as 700 ppm, the seeds of woody plants have the highest known concentrations.[[42]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley495-49)

As of April 2018 there are reports of the discovery of very large reserves of rare-earth elements on a tiny Japanese island. [Minami-Torishima Island](https://en.wikipedia.org/wiki/Minami-Tori-shima), also known as Marcus Island, is described as having "tremendous potential" for rare-earth elements and yttrium (REY), according to a study published in Scientific Reports.

"This REY-rich mud has great potential as a rare-earth metal resource because of the enormous amount available and its advantageous mineralogical features," the study reads. The study shows that more than 16 million tons of rare-earth elements could be "exploited in the near future."

Including ytrrium (Y), which is used in products like camera lenses and mobile phone screens, the rare-earth elements found are: Europium (EU), Terbium (Tb) and Dysprosium (Dy).[[43]](https://en.wikipedia.org/wiki/Yttrium#cite_note-50)

**Production**

Since yttrium is chemically so similar to the lanthanides, it occurs in the same ores ([rare-earth minerals](https://en.wikipedia.org/wiki/Rare-earth_mineral)) and is extracted by the same refinement processes. A slight distinction is recognized between the light (LREE) and the heavy rare-earth elements (HREE), but the distinction is not perfect. Yttrium is concentrated in the HREE group because of its ion size, though it has a lower [atomic mass](https://en.wikipedia.org/wiki/Atomic_mass).[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51)[[45]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Kanazawaa-52)

[](https://en.wikipedia.org/wiki/File:Yttrium_1.jpg)

A piece of yttrium. Yttrium is difficult to separate from other rare-earth elements.

Rare-earth elements (REEs) come mainly from four sources:[[46]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Naumov-53)

* Carbonate and fluoride containing ores such as the LREE [bastnäsite](https://en.wikipedia.org/wiki/Bastn%C3%A4site) ([(Ce, La, etc.)(CO3)F]) contain an average of 0.1%[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6)[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51) of yttrium compared to the 99.9% for the 16 other REEs.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51) The main source for bastnäsite from the 1960s to the 1990s was the [Mountain Pass rare earth mine](https://en.wikipedia.org/wiki/Mountain_Pass_rare_earth_mine) in California, making the United States the largest producer of REEs during that period.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51)[[46]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Naumov-53) The name "bastnäsite" is actually a group name, and the Levinson suffix is used in the correct mineral names, e.g., bästnasite-(Y) has Y as a prevailing element.[[47]](https://en.wikipedia.org/wiki/Yttrium#cite_note-54)[[48]](https://en.wikipedia.org/wiki/Yttrium#cite_note-55)[[49]](https://en.wikipedia.org/wiki/Yttrium#cite_note-56)
* [Monazite](https://en.wikipedia.org/wiki/Monazite) ([([Ce](https://en.wikipedia.org/wiki/Cerium), [La](https://en.wikipedia.org/wiki/Lanthanum), etc.)[PO4](https://en.wikipedia.org/wiki/Phosphate)]), which is mostly phosphate, is a [placer deposit](https://en.wikipedia.org/wiki/Placer_deposit) of sand created by the transportation and gravitational separation of eroded granite. Monazite as a LREE ore contains 2%[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51) (or 3%)[[50]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Stwertka116-57) yttrium. The largest deposits were found in India and Brazil in the early 20th century, making those two countries the largest producers of yttrium in the first half of that century.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51)[[46]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Naumov-53) Of the monazite group, the Ce-dominant member, monazite-(Ce), is the most common one.[[51]](https://en.wikipedia.org/wiki/Yttrium#cite_note-58)
* [Xenotime](https://en.wikipedia.org/wiki/Xenotime), a REE phosphate, is the main HREE ore containing as much as 60% yttrium as [yttrium phosphate](https://en.wikipedia.org/wiki/Yttrium_phosphate) (YPO4).[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51) This applies to xenotime-(Y).[[52]](https://en.wikipedia.org/wiki/Yttrium#cite_note-59)[[53]](https://en.wikipedia.org/wiki/Yttrium#cite_note-60)[[54]](https://en.wikipedia.org/wiki/Yttrium#cite_note-61) The largest mine is the [Bayan Obo](https://en.wikipedia.org/wiki/Bayan_Obo) deposit in China, making China the largest exporter for HREE since the closure of the Mountain Pass mine in the 1990s.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51)[[46]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Naumov-53)
* Ion absorption clays or Lognan clays are the weathering products of granite and contain only 1% of REEs.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51) The final ore concentrate can contain as much as 8% yttrium. Ion absorption clays are mostly in southern China.[[44]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Morteani-51)[[46]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Naumov-53)[[55]](https://en.wikipedia.org/wiki/Yttrium#cite_note-62) Yttrium is also found in [samarskite](https://en.wikipedia.org/wiki/Samarskite) and [fergusonite](https://en.wikipedia.org/wiki/Fergusonite) (which also stand for group names).[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47)

One method for obtaining pure yttrium from the mixed oxide ores is to dissolve the oxide in [sulfuric acid](https://en.wikipedia.org/wiki/Sulfuric_acid) and fractionate it by [ion exchange](https://en.wikipedia.org/wiki/Ion_exchange) [chromatography](https://en.wikipedia.org/wiki/Chromatography). With the addition of [oxalic acid](https://en.wikipedia.org/wiki/Oxalic_acid), the yttrium oxalate precipitates. The oxalate is converted into the oxide by heating under oxygen. By reacting the resulting yttrium oxide with [hydrogen fluoride](https://en.wikipedia.org/wiki/Hydrogen_fluoride), [yttrium fluoride](https://en.wikipedia.org/wiki/Yttrium_fluoride) is obtained.[[56]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Holleman-63) When quaternary ammonium salts are used as extractants, most yttrium will remain in the aqueous phase. When the [counter-ion](https://en.wikipedia.org/wiki/Counterion) is nitrate, the light lanthanides are removed, and when the counter-ion is thiocyanate, the heavy lanthanides are removed. In this way, yttrium salts of 99.999% purity are obtained. In the usual situation, where yttrium is in a mixture that is two-thirds heavy-lanthanide, yttrium should be removed as soon as possible to facilitate the separation of the remaining elements.

Annual world production of yttrium oxide had reached 600 [tonnes](https://en.wikipedia.org/wiki/Tonne) by 2001; by 2014 it had increased to 7,000 tons.[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47)[[57]](https://en.wikipedia.org/wiki/Yttrium#cite_note-USGS-mcs15-Y-64) Global reserves of yttrium oxide were estimated in 2014 to be more than 500,000 tons. The leading countries for these reserves included Australia, Brazil, China, India, and the United States.[[57]](https://en.wikipedia.org/wiki/Yttrium#cite_note-USGS-mcs15-Y-64) Only a few tonnes of yttrium metal are produced each year by reducing [yttrium fluoride](https://en.wikipedia.org/wiki/Yttrium(III)_fluoride) to a [metal sponge](https://en.wikipedia.org/wiki/Metal_sponge) with [calcium](https://en.wikipedia.org/wiki/Calcium) [magnesium](https://en.wikipedia.org/wiki/Magnesium) alloy. The temperature of an [arc furnace](https://en.wikipedia.org/wiki/Arc_furnace) of greater than 1,600 °C is sufficient to melt the yttrium.[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47)[[56]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Holleman-63)

**Applications**

**Consumer**

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

Yttrium is one of the elements that was used to make the red color in [CRT televisions](https://en.wikipedia.org/wiki/CRT_television)

The red component of [color television](https://en.wikipedia.org/wiki/Color_television) [cathode ray tubes](https://en.wikipedia.org/wiki/Cathode_ray_tube) is typically emitted from an [yttria (Y  
2O  
3)](https://en.wikipedia.org/wiki/Yttrium(III)_oxide) or yttrium oxide sulfide (Y  
2O  
2S) host lattice [doped](https://en.wikipedia.org/wiki/Doping_(semiconductor)) with [europium (III)](https://en.wikipedia.org/wiki/Europium) cation (Eu3+) [phosphors](https://en.wikipedia.org/wiki/Phosphor).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6)[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7)[[note 8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-65) The red color itself is emitted from the europium while the yttrium collects energy from the [electron gun](https://en.wikipedia.org/wiki/Electron_gun) and passes it to the phosphor.[[58]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE818-66) Yttrium compounds can serve as host lattices for doping with different [lanthanide](https://en.wikipedia.org/wiki/Lanthanide) cations. [Tb3+](https://en.wikipedia.org/wiki/Terbium) can be used as a doping agent to produce green [luminescence](https://en.wikipedia.org/wiki/Luminescence). As such yttrium compounds such as yttrium aluminium garnet (YAG) are useful for phosphors and are an important component of white [LEDs](https://en.wikipedia.org/wiki/LED).

Yttria is used as a [sintering](https://en.wikipedia.org/wiki/Sintering) additive in the production of porous [silicon nitride](https://en.wikipedia.org/wiki/Silicon_nitride).[[59]](https://en.wikipedia.org/wiki/Yttrium#cite_note-67) It is used as a common starting material for [material science](https://en.wikipedia.org/wiki/Material_science) and for producing other compounds of yttrium.

Yttrium compounds are used as a [catalyst](https://en.wikipedia.org/wiki/Catalyst) for [ethylene](https://en.wikipedia.org/wiki/Ethylene) [polymerization](https://en.wikipedia.org/wiki/Polymerization).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) As a metal, yttrium is used on the electrodes of some high-performance [spark plugs](https://en.wikipedia.org/wiki/Spark_plugs).[[60]](https://en.wikipedia.org/wiki/Yttrium#cite_note-68) Yttrium is used in [gas mantles](https://en.wikipedia.org/wiki/Gas_mantle) for [propane](https://en.wikipedia.org/wiki/Propane) [lanterns](https://en.wikipedia.org/wiki/Lantern) as a replacement for [thorium](https://en.wikipedia.org/wiki/Thorium), which is [radioactive](https://en.wikipedia.org/wiki/Radioactive).[[61]](https://en.wikipedia.org/wiki/Yttrium#cite_note-69)

Currently under development is yttrium-stabilized zirconia as a solid electrolyte and as an [oxygen sensor](https://en.wikipedia.org/wiki/Oxygen_sensor) in automobile exhaust systems.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7)

**Garnets**

[](https://en.wikipedia.org/wiki/File:Yag-rod.jpg)

Nd:YAG laser rod 0.5 cm in diameter

Yttrium is used in the production of a large variety of [synthetic garnets](https://en.wikipedia.org/wiki/Garnet#Synthetic_garnets),[[62]](https://en.wikipedia.org/wiki/Yttrium#cite_note-70) and yttria is used to make [yttrium iron garnets](https://en.wikipedia.org/wiki/Yttrium_iron_garnet) (Y  
3Fe  
5O  
12, also "YIG"), which are very effective [microwave](https://en.wikipedia.org/wiki/Microwave) [filters](https://en.wikipedia.org/wiki/Electronic_filter).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) Yttrium, [iron](https://en.wikipedia.org/wiki/Iron), [aluminium](https://en.wikipedia.org/wiki/Aluminium), and [gadolinium](https://en.wikipedia.org/wiki/Gadolinium) garnets (e.g. Y3(Fe,Al)5O12 and Y3(Fe,Ga)5O12) have important [magnetic](https://en.wikipedia.org/wiki/Magnetism) properties.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) YIG is also very efficient as an acoustic energy transmitter and transducer.[[63]](https://en.wikipedia.org/wiki/Yttrium#cite_note-71) [Yttrium aluminium garnet](https://en.wikipedia.org/wiki/Yttrium_aluminium_garnet) (Y  
3Al  
5O  
12 or YAG) has a [hardness](https://en.wikipedia.org/wiki/Mohs_scale_of_mineral_hardness) of 8.5 and is also used as a [gemstone](https://en.wikipedia.org/wiki/Gemstone) in jewelry (simulated [diamond](https://en.wikipedia.org/wiki/Diamond)).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) [Cerium](https://en.wikipedia.org/wiki/Cerium)-doped yttrium aluminium garnet (YAG:Ce) crystals are used as phosphors to make white [LEDs](https://en.wikipedia.org/wiki/LED).[[64]](https://en.wikipedia.org/wiki/Yttrium#cite_note-72)[[65]](https://en.wikipedia.org/wiki/Yttrium#cite_note-73)[[66]](https://en.wikipedia.org/wiki/Yttrium#cite_note-74)

[YAG](https://en.wikipedia.org/wiki/YAG), yttria, [yttrium lithium fluoride](https://en.wikipedia.org/wiki/Yttrium_lithium_fluoride) (LiYF  
4), and [yttrium orthovanadate](https://en.wikipedia.org/wiki/Yttrium_orthovanadate) (YVO  
4) are used in combination with [dopants](https://en.wikipedia.org/wiki/Dopant) such as [neodymium](https://en.wikipedia.org/wiki/Neodymium), [erbium](https://en.wikipedia.org/wiki/Erbium), [ytterbium](https://en.wikipedia.org/wiki/Ytterbium) in near-[infrared](https://en.wikipedia.org/wiki/Infrared) [lasers](https://en.wikipedia.org/wiki/Laser).[[67]](https://en.wikipedia.org/wiki/Yttrium#cite_note-cw-75)[[68]](https://en.wikipedia.org/wiki/Yttrium#cite_note-76) YAG lasers can operate at high power and are used for drilling and cutting metal.[[50]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Stwertka116-57) The single crystals of doped YAG are normally produced by the [Czochralski process](https://en.wikipedia.org/wiki/Czochralski_process).[[69]](https://en.wikipedia.org/wiki/Yttrium#cite_note-77)

**Material enhancer**

Small amounts of yttrium (0.1 to 0.2%) have been used to reduce the grain sizes of [chromium](https://en.wikipedia.org/wiki/Chromium), [molybdenum](https://en.wikipedia.org/wiki/Molybdenum), [titanium](https://en.wikipedia.org/wiki/Titanium), and [zirconium](https://en.wikipedia.org/wiki/Zirconium).[[70]](https://en.wikipedia.org/wiki/Yttrium#cite_note-78) Yttrium is used to increase the [strength](https://en.wikipedia.org/wiki/Strength_of_materials) of aluminium and [magnesium](https://en.wikipedia.org/wiki/Magnesium) alloys.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) The addition of yttrium to alloys generally improves workability, adds resistance to high-temperature recrystallization, and significantly enhances resistance to high-temperature [oxidation](https://en.wikipedia.org/wiki/Oxidation) (see graphite nodule discussion below).[[58]](https://en.wikipedia.org/wiki/Yttrium#cite_note-ECE818-66)

Yttrium can be used to [deoxidize](https://en.wikipedia.org/wiki/Deoxidizer) [vanadium](https://en.wikipedia.org/wiki/Vanadium) and other [non-ferrous metals](https://en.wikipedia.org/wiki/Non-ferrous_metal).[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) [Yttria](https://en.wikipedia.org/wiki/Yttria) stabilizes the [cubic form of zirconia](https://en.wikipedia.org/wiki/Cubic_zirconia) in jewelry.[[71]](https://en.wikipedia.org/wiki/Yttrium#cite_note-79)

Yttrium has been studied as a nodulizer in [ductile cast iron](https://en.wikipedia.org/wiki/Nodular_cast_iron), forming the [graphite](https://en.wikipedia.org/wiki/Graphite) into compact nodules instead of flakes to increase [ductility](https://en.wikipedia.org/wiki/Ductility) and fatigue resistance.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) Having a high [melting point](https://en.wikipedia.org/wiki/Melting_point), yttrium oxide is used in some [ceramic](https://en.wikipedia.org/wiki/Ceramic) and [glass](https://en.wikipedia.org/wiki/Glass) to impart [shock](https://en.wikipedia.org/wiki/Shock_(mechanics)) resistance and low [thermal expansion](https://en.wikipedia.org/wiki/Thermal_expansion) properties.[[6]](https://en.wikipedia.org/wiki/Yttrium#cite_note-CRC2008-6) Those same properties make such glass useful in [camera lenses](https://en.wikipedia.org/wiki/Camera_lens).[[40]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley497-47)

**Medical**

The radioactive isotope [yttrium-90](https://en.wikipedia.org/wiki/Yttrium-90) is used in drugs such as [Yttrium Y 90-DOTA-tyr3-octreotide](https://en.wikipedia.org/wiki/Yttrium_Y_90-DOTA-tyr3-octreotide) and [Yttrium Y 90 ibritumomab tiuxetan](https://en.wikipedia.org/wiki/Yttrium_Y_90_ibritumomab_tiuxetan) for the treatment of various [cancers](https://en.wikipedia.org/wiki/Cancer), including [lymphoma](https://en.wikipedia.org/wiki/Lymphoma), [leukemia](https://en.wikipedia.org/wiki/Leukemia), liver, ovarian, colorectal, pancreatic and bone cancers.[[42]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley495-49) It works by adhering to [monoclonal antibodies](https://en.wikipedia.org/wiki/Monoclonal_antibody), which in turn bind to cancer cells and kill them via intense [β-radiation](https://en.wikipedia.org/wiki/Beta_particle) from the yttrium-90 (see [Monoclonal antibody therapy](https://en.wikipedia.org/wiki/Monoclonal_antibody_therapy)).[[72]](https://en.wikipedia.org/wiki/Yttrium#cite_note-80)

A technique called [radioembolization](https://en.wikipedia.org/wiki/Selective_internal_radiation_therapy) is used to treat [hepatocellular carcinoma](https://en.wikipedia.org/wiki/Hepatocellular_carcinoma) and [liver metastasis](https://en.wikipedia.org/wiki/Metastatic_liver_disease). Radioembolization is a low toxicity, targeted liver cancer therapy that uses millions of tiny beads made of glass or resin containing radioactive yttrium-90. The radioactive microspheres are delivered directly to the blood vessels feeding specific liver tumors/segments or lobes. It is minimally invasive and patients can usually be discharged after a few hours. This procedure may not eliminate all tumors throughout the entire liver, but works on one segment or one lobe at a time and may require multiple procedures.[[73]](https://en.wikipedia.org/wiki/Yttrium#cite_note-81)

Also see Radioembolization in the case of combined cirrhosis and Hepatocellular carcinoma.

Needles made of yttrium-90, which can cut more precisely than scalpels, have been used to sever pain-transmitting [nerves](https://en.wikipedia.org/wiki/Nerve) in the [spinal cord](https://en.wikipedia.org/wiki/Spinal_cord),[[29]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley496-32) and yttrium-90 is also used to carry out radionuclide [synovectomy](https://en.wikipedia.org/wiki/Synovectomy) in the treatment of inflamed joints, especially knees, in sufferers of conditions such as [rheumatoid arthritis](https://en.wikipedia.org/wiki/Rheumatoid_arthritis).[[74]](https://en.wikipedia.org/wiki/Yttrium#cite_note-82)

A neodymium-doped yttrium-aluminium-garnet laser has been used in an experimental, robot-assisted radical [prostatectomy](https://en.wikipedia.org/wiki/Prostatectomy) in canines in an attempt to reduce collateral nerve and tissue damage,[[75]](https://en.wikipedia.org/wiki/Yttrium#cite_note-83) and erbium-doped lasers are coming into use for cosmetic skin resurfacing.[[7]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Cotton-7)

**Superconductors**

Main article: [high-temperature superconductor](https://en.wikipedia.org/wiki/High-temperature_superconductor)

[](https://en.wikipedia.org/wiki/File:YBCO-modified.jpg)

[YBCO](https://en.wikipedia.org/wiki/YBCO) superconductor

Yttrium is a key ingredient in the [yttrium barium copper oxide](https://en.wikipedia.org/wiki/Yttrium_barium_copper_oxide) (YBa2Cu3O7, aka 'YBCO' or '1-2-3') [superconductor](https://en.wikipedia.org/wiki/Superconductor) developed at the [University of Alabama](https://en.wikipedia.org/wiki/University_of_Alabama) and the [University of Houston](https://en.wikipedia.org/wiki/University_of_Houston) in 1987.[[38]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Wu-44) This superconductor is notable because the operating superconductivity temperature is above [liquid nitrogen](https://en.wikipedia.org/wiki/Liquid_nitrogen)'s boiling point (77.1 K).[[38]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Wu-44) Since liquid nitrogen is less expensive than the [liquid helium](https://en.wikipedia.org/wiki/Liquid_helium) required for metallic superconductors, the operating costs for applications would be less.

The actual superconducting material is often written as YBa2Cu3O7–*d*, where *d* must be less than 0.7 for superconductivity. The reason for this is still not clear, but it is known that the vacancies occur only in certain places in the crystal, the copper oxide planes, and chains, giving rise to a peculiar oxidation state of the copper atoms, which somehow leads to the superconducting behavior.

The theory of low temperature superconductivity has been well understood since the [BCS theory](https://en.wikipedia.org/wiki/BCS_theory) of 1957. It is based on a peculiarity of the interaction between two electrons in a crystal lattice. However, the BCS theory does not explain high temperature superconductivity, and its precise mechanism is still a mystery. What is known is that the composition of the copper-oxide materials must be precisely controlled for superconductivity to occur.[[76]](https://en.wikipedia.org/wiki/Yttrium#cite_note-84)

This superconductor is a black and green, multi-crystal, multi-phase mineral. Researchers are studying a class of materials known as [perovskites](https://en.wikipedia.org/wiki/Perovskite) that are alternative combinations of these elements, hoping to develop a practical [high-temperature superconductor](https://en.wikipedia.org/wiki/High-temperature_superconductor).[[50]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Stwertka116-57)

**Precautions**

Yttrium currently has no biological role, and it can be highly [toxic](https://en.wikipedia.org/wiki/Toxicity) to humans and other animals.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8)

Water-soluble compounds of yttrium are considered mildly toxic, while its insoluble compounds are non-toxic.[[42]](https://en.wikipedia.org/wiki/Yttrium#cite_note-Emsley495-49) In experiments on animals, yttrium and its compounds caused lung and liver damage, though toxicity varies with different yttrium compounds. In rats, inhalation of yttrium citrate caused [pulmonary edema](https://en.wikipedia.org/wiki/Pulmonary_edema) and [dyspnea](https://en.wikipedia.org/wiki/Dyspnea), while inhalation of [yttrium chloride](https://en.wikipedia.org/wiki/Yttrium_chloride) caused liver edema, [pleural effusions](https://en.wikipedia.org/wiki/Pleural_effusion), and pulmonary hyperemia.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8)

Exposure to yttrium compounds in humans may cause lung disease.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8) Workers exposed to airborne yttrium europium vanadate dust experienced mild eye, skin, and upper respiratory tract irritation—though this may be caused by the [vanadium](https://en.wikipedia.org/wiki/Vanadium) content rather than the yttrium.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8) Acute exposure to yttrium compounds can cause shortness of breath, coughing, chest pain, and [cyanosis](https://en.wikipedia.org/wiki/Cyanosis).[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8) The [Occupational Safety and Health Administration](https://en.wikipedia.org/wiki/Occupational_Safety_and_Health_Administration) (OSHA) [limits](https://en.wikipedia.org/wiki/Permissible_exposure_limit) exposure to yttrium in the workplace to 1 mg/m3 over an 8-hour workday. The [National Institute for Occupational Safety and Health](https://en.wikipedia.org/wiki/National_Institute_for_Occupational_Safety_and_Health) (NIOSH) [recommended exposure limit](https://en.wikipedia.org/wiki/Recommended_exposure_limit) (REL) is 1 mg/m3 over an 8-hour workday. At levels of 500 mg/m3, yttrium is [immediately dangerous to life and health](https://en.wikipedia.org/wiki/IDLH).[[77]](https://en.wikipedia.org/wiki/Yttrium#cite_note-85) Yttrium dust is flammable.[[8]](https://en.wikipedia.org/wiki/Yttrium#cite_note-osha-8)

**See also**

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**Notes**

 Essentially, a [neutron](https://en.wikipedia.org/wiki/Neutron) becomes a [proton](https://en.wikipedia.org/wiki/Proton) while an [electron](https://en.wikipedia.org/wiki/Electron) and [antineutrino](https://en.wikipedia.org/wiki/Antineutrino) are emitted.

  See: [magic number](https://en.wikipedia.org/wiki/Magic_number_(physics)). This stability is thought to result from their very low [neutron-capture cross-section](https://en.wikipedia.org/wiki/Neutron_cross-section). ([Greenwood 1997](https://en.wikipedia.org/wiki/Yttrium#CITEREFGreenwood1997), pp. 12–13). Electron emission of isotopes with those mass numbers is simply less prevalent due to this stability, resulting in them having a higher abundance.

  Metastable isomers have higher-than-normal energy states than the corresponding non-excited nucleus and these states last until a [gamma ray](https://en.wikipedia.org/wiki/Gamma_ray) or [conversion electron](https://en.wikipedia.org/wiki/Conversion_electron) is emitted from the isomer. They are designated by an 'm' being placed next to the isotope's mass number.

  *Ytterbite* was named after the village it was discovered near, plus the -ite ending to indicate it was a mineral.

  [Stwertka 1998](https://en.wikipedia.org/wiki/Yttrium#Stwertka1998), p. 115 says that the identification occurred in 1789 but is silent on when the announcement was made. [Van der Krogt 2005](https://en.wikipedia.org/wiki/Yttrium#Krogt) cites the original publication, with the year [1794, by Gadolin](https://en.wikipedia.org/wiki/Yttrium#Gadolin1794).

  Earths were given an -a ending and new elements are normally given an -ium ending

  [Tc](https://en.wikipedia.org/wiki/Critical_temperature#superconductivity) for [YBCO](https://en.wikipedia.org/wiki/YBCO) is 93 K and the boiling point of nitrogen is 77 K.

1.  [Emsley 2001](https://en.wikipedia.org/wiki/Yttrium#Emsley2001), p. 497 says that "[Yttrium oxysulfide](https://en.wikipedia.org/w/index.php?title=Yttrium_oxysulfide&action=edit&redlink=1), doped with europium (III), was used as the standard red component in colour televisions", and Jackson and Christiansen (1993) state that 5–10 g yttrium oxide and 0.5–1 g europium oxide were required to produce a single TV screen, as quoted in [Gupta and Krishnamurthy](https://en.wikipedia.org/wiki/Yttrium#Gupta).

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| * [**v**](https://en.wikipedia.org/wiki/Template:Yttrium_compounds) * [**t**](https://en.wikipedia.org/wiki/Template_talk:Yttrium_compounds) * [**e**](https://en.wikipedia.org/w/index.php?title=Template:Yttrium_compounds&action=edit)   **Yttrium compounds** | |

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