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**Krypton**

From Wikipedia, the free encyclopedia

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

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

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| --- | --- |
| Krypton,  36Kr | |
| [Krypton discharge tube.jpg](https://en.wikipedia.org/wiki/File:Krypton_discharge_tube.jpg)  A krypton-filled [discharge](https://en.wikipedia.org/wiki/Gas-filled_tube) tube glowing white | |
| **General properties** | |
| **Pronunciation** | [/ˈkrɪptɒn/](https://en.wikipedia.org/wiki/Help:IPA/English) ​([*KRIP-ton*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key)) |
| **Appearance** | colorless gas, exhibiting a whitish glow in an electric field |
| [**Standard atomic weight**](https://en.wikipedia.org/wiki/Standard_atomic_weight) **(*A*r, standard)** | 83.798(2)[[1]](https://en.wikipedia.org/wiki/Krypton#cite_note-CIAAW2016-1) |
| **Krypton 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 | | [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) | | [Ar](https://en.wikipedia.org/wiki/Argon) ↑ **Kr** ↓ [Xe](https://en.wikipedia.org/wiki/Xenon) | | [bromine](https://en.wikipedia.org/wiki/Bromine) ← **krypton** → [rubidium](https://en.wikipedia.org/wiki/Rubidium) | | | | |
| [**Atomic number**](https://en.wikipedia.org/wiki/Atomic_number)(*Z*) | 36 |
| [**Group**](https://en.wikipedia.org/wiki/Group_(periodic_table)) | [group 18 (noble gases)](https://en.wikipedia.org/wiki/Noble_gas) |
| [**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) | [noble gas](https://en.wikipedia.org/wiki/Noble_gas) |
| [**Electron configuration**](https://en.wikipedia.org/wiki/Electron_configuration) | [[Ar](https://en.wikipedia.org/wiki/Argon)] 3d10 4s2 4p6 |
| Electrons per shell | 2, 8, 18, 8 |
| **Physical properties** | |
| [**Phase**](https://en.wikipedia.org/wiki/Phase_(matter)) **at**[**STP**](https://en.wikipedia.org/wiki/Standard_conditions_for_temperature_and_pressure) | [gas](https://en.wikipedia.org/wiki/Gas) |
| [**Melting point**](https://en.wikipedia.org/wiki/Melting_point) | 115.78 [K](https://en.wikipedia.org/wiki/Kelvin) ​(−157.37 °C, ​−251.27 °F) |
| [**Boiling point**](https://en.wikipedia.org/wiki/Boiling_point) | 119.93 K ​(−153.415 °C, ​−244.147 °F) |
| [**Density**](https://en.wikipedia.org/wiki/Density)(at STP) | 3.749 g/L |
| when liquid (at b.p.) | 2.413 g/cm3[[2]](https://en.wikipedia.org/wiki/Krypton#cite_note-2) |
| [**Triple point**](https://en.wikipedia.org/wiki/Triple_point) | 115.775 K, ​73.53 kPa[[3]](https://en.wikipedia.org/wiki/Krypton#cite_note-3)[[4]](https://en.wikipedia.org/wiki/Krypton#cite_note-b92-4) |
| [**Critical point**](https://en.wikipedia.org/wiki/Critical_point_(thermodynamics)) | 209.48 K, 5.525 MPa[[4]](https://en.wikipedia.org/wiki/Krypton#cite_note-b92-4) |
| [**Heat of fusion**](https://en.wikipedia.org/wiki/Enthalpy_of_fusion) | 1.64 [kJ/mol](https://en.wikipedia.org/wiki/Kilojoule_per_mole) |
| [**Heat of vaporization**](https://en.wikipedia.org/wiki/Enthalpy_of_vaporization) | 9.08 kJ/mol |
| [**Molar heat capacity**](https://en.wikipedia.org/wiki/Molar_heat_capacity) | 20.95[[5]](https://en.wikipedia.org/wiki/Krypton#cite_note-5) 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) | 59 | 65 | 74 | 84 | 99 | 120 | | |
| **Atomic properties** | |
| [**Oxidation states**](https://en.wikipedia.org/wiki/Oxidation_state) | **0**, +1, +2 (rarely more than 0; [oxide](https://en.wikipedia.org/wiki/Oxide) is unknown) |
| [**Electronegativity**](https://en.wikipedia.org/wiki/Electronegativity) | Pauling scale: 3.00 |
| [**Ionization energies**](https://en.wikipedia.org/wiki/Ionization_energy) | * 1st: 1350.8 kJ/mol * 2nd: 2350.4 kJ/mol * 3rd: 3565 kJ/mol |
| [**Covalent radius**](https://en.wikipedia.org/wiki/Covalent_radius) | 116±4 [pm](https://en.wikipedia.org/wiki/Picometre) |
| [**Van der Waals radius**](https://en.wikipedia.org/wiki/Van_der_Waals_radius) | 202 pm |
| [Color lines in a spectral range](https://en.wikipedia.org/wiki/File:Krypton_spectrum_visible.png)  [**Spectral lines**](https://en.wikipedia.org/wiki/Spectral_line) **of krypton** | |
| **Other properties** | |
| [**Crystal structure**](https://en.wikipedia.org/wiki/Crystal_structure) | ​[face-centered cubic](https://en.wikipedia.org/wiki/Cubic_crystal_system) (fcc)  [Face-centered cubic crystal structure for krypton](https://en.wikipedia.org/wiki/File:Cubic-face-centered.svg) |
| [**Speed of sound**](https://en.wikipedia.org/wiki/Speed_of_sound) | (gas, 23 °C) 220 m·s−1 (liquid) 1120 [m/s](https://en.wikipedia.org/wiki/Metre_per_second) |
| [**Thermal conductivity**](https://en.wikipedia.org/wiki/Thermal_conductivity) | 9.43×10−3  W/(m·K) |
| [**Magnetic ordering**](https://en.wikipedia.org/wiki/Magnetism) | [diamagnetic](https://en.wikipedia.org/wiki/Diamagnetic)[[6]](https://en.wikipedia.org/wiki/Krypton#cite_note-6) |
| [**Magnetic susceptibility**](https://en.wikipedia.org/wiki/Magnetic_susceptibility) | −28.8·10−6 cm3/mol (298 K)[[7]](https://en.wikipedia.org/wiki/Krypton#cite_note-7) |
| [**CAS Number**](https://en.wikipedia.org/wiki/CAS_Registry_Number) | 7439-90-9 |
| **History** | |
| [**Discovery**](https://en.wikipedia.org/wiki/Timeline_of_chemical_element_discoveries) **and first isolation** | [William Ramsay](https://en.wikipedia.org/wiki/William_Ramsay) and [Morris Travers](https://en.wikipedia.org/wiki/Morris_Travers) (1898) |
| **Main** [**isotopes of krypton**](https://en.wikipedia.org/wiki/Isotopes_of_krypton) | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | [**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) | | **78Kr** | 0.36% | 9.2×1021 y[[8]](https://en.wikipedia.org/wiki/Krypton#cite_note-Patrignani2016-8) | [εε](https://en.wikipedia.org/wiki/Double_electron_capture) | [78Se](https://en.wikipedia.org/wiki/Selenium-78) | | **79Kr** | [syn](https://en.wikipedia.org/wiki/Synthetic_radioisotope) | 35 h | [ε](https://en.wikipedia.org/wiki/Electron_capture) | [79Br](https://en.wikipedia.org/wiki/Bromine-79) | | [β+](https://en.wikipedia.org/wiki/Positron_emission) | 79Br | | [γ](https://en.wikipedia.org/wiki/Gamma_radiation) | – | | **80Kr** | 2.29% | stable | | | | **81Kr** | [trace](https://en.wikipedia.org/wiki/Trace_radioisotope) | 2.3×105 y | ε | [81Br](https://en.wikipedia.org/wiki/Bromine-81) | | γ | – | | **82Kr** | 11.59% | stable | | | | **83Kr** | 11.50% | stable | | | | **84Kr** | 56.99% | stable | | | | [**85Kr**](https://en.wikipedia.org/wiki/Krypton-85) | syn | 11 y | [β−](https://en.wikipedia.org/wiki/Beta_emission) | [85Rb](https://en.wikipedia.org/wiki/Rubidium-85) | | **86Kr** | 17.28% | stable | | | | |
| * [view](https://en.wikipedia.org/wiki/Template:Infobox_krypton) * [talk](https://en.wikipedia.org/wiki/Template_talk:Infobox_krypton) * [edit](https://en.wikipedia.org/w/index.php?title=Template:Infobox_krypton&action=edit)   | [references](https://en.wikipedia.org/wiki/List_of_data_references_for_chemical_elements) | |

**Krypton** (from [Ancient Greek](https://en.wikipedia.org/wiki/Ancient_Greek_language): κρυπτός, [translit.](https://en.wikipedia.org/wiki/Romanization_of_Ancient_Greek) *kryptos* "the hidden one") is a [chemical element](https://en.wikipedia.org/wiki/Chemical_element) with symbol **Kr** and [atomic number](https://en.wikipedia.org/wiki/Atomic_number) 36. It is a member of [group 18 (noble gases)](https://en.wikipedia.org/wiki/Noble_gas) elements. A colorless, odorless, tasteless [noble gas](https://en.wikipedia.org/wiki/Noble_gas), krypton occurs in [trace amounts](https://en.wikipedia.org/wiki/Trace_element) in the [atmosphere](https://en.wikipedia.org/wiki/Earth%27s_atmosphere) and is often used with other rare gases in [fluorescent lamps](https://en.wikipedia.org/wiki/Fluorescent_lamp). With rare exceptions, krypton is chemically [inert](https://en.wikipedia.org/wiki/Chemically_inert).

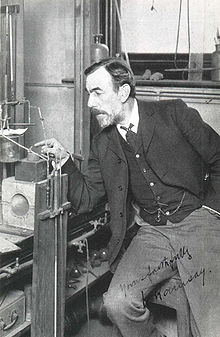
Krypton, like the other [noble gases](https://en.wikipedia.org/wiki/Noble_gases), is used in lighting and [photography](https://en.wikipedia.org/wiki/Photography). Krypton light has many [spectral lines](https://en.wikipedia.org/wiki/Spectral_lines), and krypton [plasma](https://en.wikipedia.org/wiki/Plasma_(physics)) is useful in bright, high-powered gas lasers (krypton ion and [excimer lasers](https://en.wikipedia.org/wiki/Excimer_laser)), each of which resonates and amplifies a single spectral line. [Krypton fluoride](https://en.wikipedia.org/wiki/Krypton_fluoride_laser) also makes a useful laser medium. From 1960 to 1983, the official length of a [meter](https://en.wikipedia.org/wiki/Metre) was defined by the 605 nm wavelength of the orange spectral line of krypton-86, because of the high power and relative ease of operation of krypton discharge tubes.



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**History**

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

Sir William Ramsay, the discoverer of Krypton

Krypton was discovered in [Britain](https://en.wikipedia.org/wiki/Great_Britain) in 1898 by [Sir William Ramsay](https://en.wikipedia.org/wiki/William_Ramsay), a Scottish chemist, and [Morris Travers](https://en.wikipedia.org/wiki/Morris_Travers), an English chemist, in residue left from evaporating nearly all components of liquid air. [Neon](https://en.wikipedia.org/wiki/Neon) was discovered by a similar procedure by the same workers just a few weeks later.[[9]](https://en.wikipedia.org/wiki/Krypton#cite_note-9) William Ramsay was awarded the 1904 [Nobel Prize in Chemistry](https://en.wikipedia.org/wiki/Nobel_Prize_in_Chemistry) for discovery of a series of [noble gases](https://en.wikipedia.org/wiki/Noble_gas), including krypton.

In 1960, the [International Conference on Weights and Measures](https://en.wikipedia.org/wiki/Bureau_International_des_Poids_et_Mesures) defined the meter as 1,650,763.73 [wavelengths](https://en.wikipedia.org/wiki/Wavelength) of light emitted by the krypton-86 [isotope](https://en.wikipedia.org/wiki/Isotope).[[10]](https://en.wikipedia.org/wiki/Krypton#cite_note-10)[[11]](https://en.wikipedia.org/wiki/Krypton#cite_note-11) This agreement replaced the 1889 international prototype meter located in [Paris](https://en.wikipedia.org/wiki/Paris), which was a metal bar made of a [platinum](https://en.wikipedia.org/wiki/Platinum)-[iridium](https://en.wikipedia.org/wiki/Iridium) alloy (one of a series of standard meter bars, originally constructed to be one ten-millionth of a quadrant of the [Earth](https://en.wikipedia.org/wiki/Earth)'s polar circumference). This also obsoleted the 1927 definition of the [ångström](https://en.wikipedia.org/wiki/%C3%85ngstr%C3%B6m) based on the red [cadmium](https://en.wikipedia.org/wiki/Cadmium) spectral line,[[12]](https://en.wikipedia.org/wiki/Krypton#cite_note-12) replacing it with 1 Å = 10−10 m. The krypton-86 definition lasted until the October 1983 conference, which redefined the meter as the distance that light travels in [vacuum](https://en.wikipedia.org/wiki/Vacuum) during 1/299,792,458 s.[[13]](https://en.wikipedia.org/wiki/Krypton#cite_note-13)[[14]](https://en.wikipedia.org/wiki/Krypton#cite_note-14)[[15]](https://en.wikipedia.org/wiki/Krypton#cite_note-15)

**Characteristics**

Krypton is characterized by several sharp emission lines ([spectral signatures](https://en.wikipedia.org/wiki/Spectral_signature)) the strongest being green and yellow.[[16]](https://en.wikipedia.org/wiki/Krypton#cite_note-colours-16) Krypton is one of the products of [uranium](https://en.wikipedia.org/wiki/Uranium) [fission](https://en.wikipedia.org/wiki/Nuclear_fission).[[17]](https://en.wikipedia.org/wiki/Krypton#cite_note-ANL-17) Solid krypton is white and has a face-centered [cubic](https://en.wikipedia.org/wiki/Cubic_(crystal_system)) [crystal structure](https://en.wikipedia.org/wiki/Crystal_structure), which is a common property of all noble gases (except [helium](https://en.wikipedia.org/wiki/Helium), which has a hexagonal close-packed crystal structure).

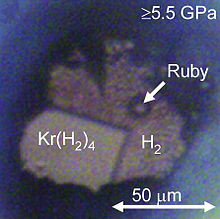
**Isotopes**

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

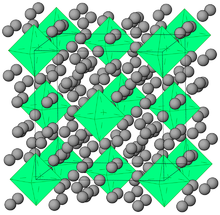
Naturally occurring krypton in Earth's atmosphere is composed of five [stable](https://en.wikipedia.org/wiki/Stable_nuclide) [isotopes](https://en.wikipedia.org/wiki/Isotopes), plus one isotope (78Kr) with such a long [half-life](https://en.wikipedia.org/wiki/Half-life) (9.2×1021 years) that it can be considered stable. (This isotope has the second-longest known half-life among all isotopes for which decay has been observed; it undergoes [double electron capture](https://en.wikipedia.org/wiki/Double_electron_capture) to 78[Se](https://en.wikipedia.org/wiki/Selenium)).[[8]](https://en.wikipedia.org/wiki/Krypton#cite_note-Patrignani2016-8)[[18]](https://en.wikipedia.org/wiki/Krypton#cite_note-18) In addition, about thirty unstable isotopes and [isomers](https://en.wikipedia.org/wiki/Nuclear_isomer) are known.[[19]](https://en.wikipedia.org/wiki/Krypton#cite_note-19) Traces of 81Kr, a [cosmogenic nuclide](https://en.wikipedia.org/wiki/Cosmogenic_nuclide) produced by the [cosmic ray](https://en.wikipedia.org/wiki/Cosmic_ray) irradiation of 80Kr, also occur in nature: this [isotope](https://en.wikipedia.org/wiki/Isotope) is [radioactive](https://en.wikipedia.org/wiki/Radioactive) with a half-life of 230,000 years. Krypton is highly volatile and does not stay in solution in near-surface [water](https://en.wikipedia.org/wiki/Water), but 81Kr has been used for dating old (50,000–800,000 years) [groundwater](https://en.wikipedia.org/wiki/Groundwater).[[20]](https://en.wikipedia.org/wiki/Krypton#cite_note-20)

[85Kr](https://en.wikipedia.org/wiki/Krypton-85) is an inert radioactive noble gas with a half-life of 10.76 years. It is produced by the [fission](https://en.wikipedia.org/wiki/Nuclear_fission) of [uranium](https://en.wikipedia.org/wiki/Uranium) and [plutonium](https://en.wikipedia.org/wiki/Plutonium), such as in [nuclear bomb](https://en.wikipedia.org/wiki/Nuclear_bomb) testing and [nuclear reactors](https://en.wikipedia.org/wiki/Nuclear_reactor). 85Kr is released during the reprocessing of [fuel rods](https://en.wikipedia.org/wiki/Fuel_rod) from nuclear reactors. Concentrations at the [North Pole](https://en.wikipedia.org/wiki/North_Pole) are 30% higher than at the [South Pole](https://en.wikipedia.org/wiki/South_Pole) due to convective mixing.[[21]](https://en.wikipedia.org/wiki/Krypton#cite_note-21)

**Chemistry**

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

Kr(H2)4 and H2 solids formed in a [diamond anvil cell](https://en.wikipedia.org/wiki/Diamond_anvil_cell).[[22]](https://en.wikipedia.org/wiki/Krypton#cite_note-KrH-22)

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

Structure of Kr(H2)4. Krypton octahedra (green) are surrounded by randomly oriented hydrogen molecules.[[22]](https://en.wikipedia.org/wiki/Krypton#cite_note-KrH-22)

Like the other noble gases, krypton is highly chemically unreactive. The rather restricted chemistry of krypton in its only known nonzero oxidation state of +2 parallels that of the neighboring element [bromine](https://en.wikipedia.org/wiki/Bromine) in the +1 oxidation state; due to the [scandide contraction](https://en.wikipedia.org/wiki/Scandide_contraction) it is difficult to oxidize the 4p elements to their group oxidation states. Before the 1960s, no noble gas compounds had been synthesized.[[23]](https://en.wikipedia.org/wiki/Krypton#cite_note-S&E-23)

However, following the first successful synthesis of [xenon](https://en.wikipedia.org/wiki/Xenon) compounds in 1962, synthesis of [krypton difluoride](https://en.wikipedia.org/wiki/Krypton_difluoride) (KrF  
2) was reported in 1963. In the same year, KrF  
4 was reported by Grosse, *et al.*,[[24]](https://en.wikipedia.org/wiki/Krypton#cite_note-24) but was subsequently shown to be a mistaken identification.[[25]](https://en.wikipedia.org/wiki/Krypton#cite_note-25) Under extreme conditions, krypton reacts with fluorine to form KrF2 according to the following equation:

Kr + F2 → KrF2

Compounds with krypton bonded to atoms other than [fluorine](https://en.wikipedia.org/wiki/Fluorine) have also been discovered. There are also unverified reports of a [barium](https://en.wikipedia.org/wiki/Barium) [salt](https://en.wikipedia.org/wiki/Salt_(chemistry)) of a krypton [oxoacid](https://en.wikipedia.org/wiki/Oxoacid).[[26]](https://en.wikipedia.org/wiki/Krypton#cite_note-26) [Ar](https://en.wikipedia.org/wiki/Argon)Kr+ and Kr[H](https://en.wikipedia.org/wiki/Hydrogen)+ [polyatomic ions](https://en.wikipedia.org/wiki/Polyatomic_ions) have been investigated and there is evidence for Kr[Xe](https://en.wikipedia.org/wiki/Xenon) or KrXe+.[[27]](https://en.wikipedia.org/wiki/Krypton#cite_note-27)

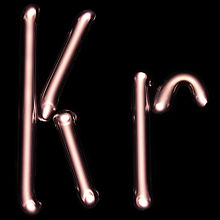
The reaction of KrF  
2 with B(OTeF  
5)  
3 produces an unstable compound, Kr(OTeF  
5)  
2, that contains a krypton-[oxygen](https://en.wikipedia.org/wiki/Oxygen) bond. A krypton-[nitrogen](https://en.wikipedia.org/wiki/Nitrogen) bond is found in the [cation](https://en.wikipedia.org/wiki/Cation) [HC≡N–Kr–F]+  
, produced by the reaction of KrF  
2 with [HC≡NH]+  
[AsF−  
6] below −50 °C.[[28]](https://en.wikipedia.org/wiki/Krypton#cite_note-28)[[29]](https://en.wikipedia.org/wiki/Krypton#cite_note-29) HKrCN and HKrC≡CH (krypton hydride-cyanide and hydrokryptoacetylene) were reported to be stable up to 40 [K](https://en.wikipedia.org/wiki/Kelvin).[[23]](https://en.wikipedia.org/wiki/Krypton#cite_note-S&E-23)

Krypton [hydride](https://en.wikipedia.org/wiki/Hydride) (Kr(H2)4) crystals can be grown at pressures above 5 GPa. They have a face-centered cubic structure where krypton octahedra are surrounded by randomly oriented hydrogen molecules.[[22]](https://en.wikipedia.org/wiki/Krypton#cite_note-KrH-22)

**Natural occurrence**

Earth has retained all of the noble gases that were present at its formation except [helium](https://en.wikipedia.org/wiki/Helium). Krypton's concentration in the [atmosphere](https://en.wikipedia.org/wiki/Earth%27s_atmosphere) is about 1 [ppm](https://en.wikipedia.org/wiki/Part_per_million). It can be extracted from liquid air by [fractional distillation](https://en.wikipedia.org/wiki/Fractional_distillation).[[30]](https://en.wikipedia.org/wiki/Krypton#cite_note-30) The amount of krypton in space is uncertain, because measurement is derived from meteoric activity and solar winds. The first measurements suggest an abundance of krypton in space.[[31]](https://en.wikipedia.org/wiki/Krypton#cite_note-31)

**Applications**

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

Krypton gas discharge tube

Krypton's multiple emission lines make ionized krypton gas discharges appear whitish, which in turn makes krypton-based bulbs useful in photography as a brilliant white light source. Krypton is used in some photographic flashes for high speed [photography](https://en.wikipedia.org/wiki/Photography). Krypton gas is also combined with other gases to make luminous signs that glow with a bright greenish-yellow light.[[32]](https://en.wikipedia.org/wiki/Krypton#cite_note-32)

Krypton is mixed with [argon](https://en.wikipedia.org/wiki/Argon) in energy efficient fluorescent lamps, reducing the power consumption, but also reducing the light output and raising the cost.[[33]](https://en.wikipedia.org/wiki/Krypton#cite_note-33) Krypton costs about 100 times as much as argon. Krypton (along with xenon) is also used to fill incandescent lamps to reduce filament evaporation and allow higher [operating temperatures](https://en.wikipedia.org/wiki/Operating_temperature).[[34]](https://en.wikipedia.org/wiki/Krypton#cite_note-34) A brighter light results with more blue color than conventional incandescent lamps.

Krypton's white discharge is often used to good effect in colored gas discharge tubes, which are simply painted or stained to create the desired color (for example, "[neon](https://en.wikipedia.org/wiki/Neon)" type multi-colored advertising signs are often entirely krypton-based). Krypton produces much higher light power than neon in the red spectral line region, and for this reason, red lasers for high-power laser light-shows are often krypton lasers with mirrors that select the red spectral line for laser amplification and emission, rather than the more familiar helium-neon variety, which could not achieve the same multi-watt outputs.[[35]](https://en.wikipedia.org/wiki/Krypton#cite_note-35)

The [krypton fluoride laser](https://en.wikipedia.org/wiki/Krypton_fluoride_laser) is important in nuclear fusion energy research in confinement experiments. The [laser](https://en.wikipedia.org/wiki/Laser) has high beam uniformity, short [wavelength](https://en.wikipedia.org/wiki/Wavelength), and the spot size can be varied to track an imploding pellet.[[36]](https://en.wikipedia.org/wiki/Krypton#cite_note-36)

In experimental [particle physics](https://en.wikipedia.org/wiki/Particle_physics), liquid krypton is used to construct quasi-homogeneous electromagnetic [calorimeters](https://en.wikipedia.org/wiki/Calorimeter_(particle_physics)). A notable example is the calorimeter of the [NA48](https://en.wikipedia.org/wiki/NA48) experiment at [CERN](https://en.wikipedia.org/wiki/CERN) containing about 27 [tonnes](https://en.wikipedia.org/wiki/Tonne) of liquid krypton. This usage is rare, since liquid [argon](https://en.wikipedia.org/wiki/Argon) is less expensive. The advantage of krypton is a smaller [Molière radius](https://en.wikipedia.org/wiki/Moli%C3%A8re_radius) of 4.7 cm, which provides excellent spatial resolution with little overlapping. The other parameters relevant for calorimetry are: [radiation length](https://en.wikipedia.org/wiki/Radiation_length) of X0=4.7 cm, and density of 2.4 g/cm3.

The sealed spark gap assemblies in ignition exciters in some older jet engines contain a small amount of krypton-85 to produce consistent ionization levels and uniform operation.

Krypton-83 has application in [magnetic resonance imaging](https://en.wikipedia.org/wiki/Magnetic_resonance_imaging) (MRI) for imaging airways. In particular, it enables the radiologist to distinguish between [hydrophobic](https://en.wikipedia.org/wiki/Hydrophobe) and hydrophilic surfaces containing an airway.[[37]](https://en.wikipedia.org/wiki/Krypton#cite_note-Pavlovskaya-37)

Although xenon has potential for use in [computed tomography](https://en.wikipedia.org/wiki/Computed_tomography) (CT) to assess regional ventilation, its anesthetic properties limit its fraction in the breathing gas to 35%. A breathing mixture of 30% xenon and 30% krypton is comparable in effectiveness for CT to a 40% xenon fraction, while avoiding the unwanted effects of a high partial pressure of xenon gas.[[38]](https://en.wikipedia.org/wiki/Krypton#cite_note-38)

The [metastable isotope](https://en.wikipedia.org/wiki/Metastable_isotope) krypton-81m is used in [nuclear medicine](https://en.wikipedia.org/wiki/Nuclear_medicine) for lung [ventilation/perfusion scans](https://en.wikipedia.org/wiki/Ventilation/perfusion_scan), where it is inhaled and imaged with a [gamma camera](https://en.wikipedia.org/wiki/Gamma_camera).[[39]](https://en.wikipedia.org/wiki/Krypton#cite_note-39)

Krypton-85 in the atmosphere has been used to detect clandestine nuclear fuel reprocessing facilities in [North Korea](https://en.wikipedia.org/wiki/North_Korea)[[40]](https://en.wikipedia.org/wiki/Krypton#cite_note-40) and [Pakistan](https://en.wikipedia.org/wiki/Pakistan).[[41]](https://en.wikipedia.org/wiki/Krypton#cite_note-41) Those facilities were detected in the early 2000s and were believed to be producing weapons-grade plutonium.

Krypton is used occasionally as an insulating gas between window panes.[[42]](https://en.wikipedia.org/wiki/Krypton#cite_note-42)

**Precautions**

Krypton is considered to be a non-toxic [asphyxiant](https://en.wikipedia.org/wiki/Asphyxiant_gas).[[43]](https://en.wikipedia.org/wiki/Krypton#cite_note-43) Krypton has a [narcotic](https://en.wikipedia.org/wiki/Narcotic) potency seven times greater than air, and breathing an atmosphere of 50% krypton and 50% natural air (as might happen in the locality of a leak) causes narcosis in humans similar to breathing air at four times atmospheric pressure. This is comparable to scuba diving at a depth of 30 m (100 ft) (see [nitrogen narcosis](https://en.wikipedia.org/wiki/Nitrogen_narcosis)) and could affect anyone breathing it. At the same time, that mixture would contain only 10% oxygen (rather than the normal 20%) and [hypoxia](https://en.wikipedia.org/wiki/Hypoxia_(medical)) would be a greater concern.

**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[***Krypton***](https://en.wikipedia.org/wiki/Book:Krypton) * 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[***Noble gases***](https://en.wikipedia.org/wiki/Book:Noble_gases) * 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) |
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  *Haynes, William M., ed. (2011).* [*CRC Handbook of Chemistry and Physics*](https://en.wikipedia.org/wiki/CRC_Handbook_of_Chemistry_and_Physics) *(92nd ed.). Boca Raton, FL:* [*CRC Press*](https://en.wikipedia.org/wiki/CRC_Press)*. p. 4.121.* [*ISBN*](https://en.wikipedia.org/wiki/International_Standard_Book_Number)[*1439855110*](https://en.wikipedia.org/wiki/Special:BookSources/1439855110)*.*

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  *Patrignani, C.; et al. (*[*Particle Data Group*](https://en.wikipedia.org/wiki/Particle_Data_Group)*) (2016). "Review of Particle Physics".* [*Chinese Physics C*](https://en.wikipedia.org/wiki/Chinese_Physics_C)*.* ***40*** *(10): 100001.* [*Bibcode*](https://en.wikipedia.org/wiki/Bibcode)*:*[*2016ChPhC..40j0001P*](http://adsabs.harvard.edu/abs/2016ChPhC..40j0001P)*.* [*doi*](https://en.wikipedia.org/wiki/Digital_object_identifier)*:*[*10.1088/1674-1137/40/10/100001*](https://doi.org/10.1088%2F1674-1137%2F40%2F10%2F100001)*.* See p. 768

  [*William Ramsay*](https://en.wikipedia.org/wiki/William_Ramsay)*; Morris W. Travers (1898). "On a New Constituent of Atmospheric Air". Proceedings of the Royal Society of London.* ***63*** *(1): 405–408.* [*doi*](https://en.wikipedia.org/wiki/Digital_object_identifier)*:*[*10.1098/rspl.1898.0051*](https://doi.org/10.1098%2Frspl.1898.0051)*.*

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* [Community portal](https://en.wikipedia.org/wiki/Wikipedia:Community_portal)
* [Recent changes](https://en.wikipedia.org/wiki/Special:RecentChanges)
* [Contact page](https://en.wikipedia.org/wiki/Wikipedia:Contact_us)

**Tools**

* [What links here](https://en.wikipedia.org/wiki/Special:WhatLinksHere/Krypton)
* [Related changes](https://en.wikipedia.org/wiki/Special:RecentChangesLinked/Krypton)
* [Upload file](https://en.wikipedia.org/wiki/Wikipedia:File_Upload_Wizard)
* [Special pages](https://en.wikipedia.org/wiki/Special:SpecialPages)
* [Permanent link](https://en.wikipedia.org/w/index.php?title=Krypton&oldid=871546398)
* [Page information](https://en.wikipedia.org/w/index.php?title=Krypton&action=info)
* [Wikidata item](https://www.wikidata.org/wiki/Special:EntityPage/Q888)
* [Cite this page](https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Krypton&id=871546398)

**Print/export**

* [Create a book](https://en.wikipedia.org/w/index.php?title=Special:Book&bookcmd=book_creator&referer=Krypton)
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* [Printable version](https://en.wikipedia.org/w/index.php?title=Krypton&printable=yes)

**In other projects**

* [Wikimedia Commons](https://commons.wikimedia.org/wiki/Category:Krypton)

**Languages**

* [Deutsch](https://de.wikipedia.org/wiki/Krypton)
* [Español](https://es.wikipedia.org/wiki/Kript%C3%B3n)
* [Français](https://fr.wikipedia.org/wiki/Krypton)
* [한국어](https://ko.wikipedia.org/wiki/%ED%81%AC%EB%A6%BD%ED%86%A4)
* [Italiano](https://it.wikipedia.org/wiki/Kripton)
* [Русский](https://ru.wikipedia.org/wiki/%D0%9A%D1%80%D0%B8%D0%BF%D1%82%D0%BE%D0%BD)
* [Tagalog](https://tl.wikipedia.org/wiki/Kripton)
* [Tiếng Việt](https://vi.wikipedia.org/wiki/Krypton)
* [中文](https://zh.wikipedia.org/wiki/%E6%B0%AA)

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