= Krypton =

Krypton (from Greek : ??????? kryptos " the hidden one ") is a chemical element with symbol Kr and atomic number 36 . It is a member of group 18 (noble gases) elements . A colorless , odorless , tasteless noble gas , krypton occurs in trace amounts in the atmosphere and is often used with other rare gases in fluorescent lamps . With rare exceptions , krypton is chemically inert .

Krypton , like the other noble gases , is used in lighting and photography . Krypton light has many spectral lines , and krypton plasma is useful in bright , high @-@ powered gas lasers (krypton ion and excimer lasers) , each of which resonates and amplifies a single spectral line . Krypton fluoride also makes a useful laser . From 1960 to 1983 , the official length of a meter 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 .

= = History = =

Krypton was discovered in Britain in 1898 by Sir William Ramsay , a Scottish chemist , and Morris Travers , an English chemist , in residue left from evaporating nearly all components of liquid air . Neon was discovered by a similar procedure by the same workers just a few weeks later . William Ramsay was awarded the 1904 Nobel Prize in Chemistry for discovery of a series of noble gases , including krypton .

In 1960 , the International Conference on Weights and Measures defined the meter as 1 @,@ 650 @,@ 763 @.@ 73 wavelengths of light emitted by the krypton @-@ 86 isotope . This agreement replaced the 1889 international prototype meter located in Paris , which was a metal bar made of a platinum @-@ iridium alloy (one of a series of standard meter bars , originally constructed to be one ten @-@ millionth of a quadrant of the Earth 's polar circumference) . This also obsoleted the 1927 definition of the ångström based on the red cadmium spectral line , 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 a vacuum during 1 / 299 @,@ 792 @,@ 458 s .

= = Characteristics = =

Krypton is characterized by several sharp emission lines (spectral signatures) the strongest being green and yellow . Krypton is one of the products of uranium fission . Solid krypton is white and has a face @-@ centered cubic crystal structure , which is a common property of all noble gases (except helium , with a hexagonal close @-@ packed crystal structure) .

= = = Isotopes = = =

Naturally occurring krypton in Earth 's atmosphere is composed of six stable isotopes . In addition , about thirty unstable isotopes and isomers are known . 81Kr , the product of atmospheric reactions , is produced with the other naturally occurring isotopes of krypton . Being radioactive , it has a half @-@ life of 230 @,@ 000 years . Krypton is highly volatile and does not stay in solution in near @-@ surface water , but 81Kr has been used for dating old (50 @,@ 000 ? 800 @,@ 000 years) groundwater .

85Kr is an inert radioactive noble gas with a half @-@ life of 10 @.@ 76 years . It is produced by the fission of uranium and plutonium , such as in nuclear bomb testing and nuclear reactors . 85Kr is released during the reprocessing of fuel rods from nuclear reactors . Concentrations at the North Pole are 30 % higher than at the South Pole due to convective mixing .

= = = Chemistry = = =

Like the other noble gases , krypton is highly chemically unreactive . In fact , before the 1960s , no noble gas compounds had been synthesized .

However , following the first successful synthesis of xenon compounds in 1962 , synthesis of krypton difluoride (KrF
2) was reported in 1963 . In the same year , KrF
4 was reported by Grosse , et al . , but was subsequently shown to be a mistaken identification . 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 have also been discovered . There are also unverified reports of a barium salt of a krypton oxoacid . ArKr + and KrH + polyatomic ions have been investigated and there is evidence for KrXe or KrXe + .
The reaction of KrF
2 with B (OTeF
5)
3 produces an unstable compound , Kr (OTeF
5)
2 , that contains a krypton @-@ oxygen bond . A krypton @-@ nitrogen bond is found in the cation [HC ? N ? Kr ? F] + , produced by the reaction of KrF
2 with [HC ? NH] + [AsF ?
6] below ? 50 ° C. HKrCN and HKrC ? CH (krypton hydride @-@ cyanide and hydrokryptoacetylene) were reported to be stable up to 40 K.
Krypton 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 .

= = = Natural occurrence = = =

Earth has retained all of the noble gases that were present at its formation except helium . Krypton 's concentration in the atmosphere is about 1 ppm . It can be extracted from liquid air by fractional distillation . 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 .

= = Applications = =

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 . Krypton gas is also combined with other gases to make luminous signs that glow with a bright greenish @-@ yellow light .
Krypton is mixed with argon in energy efficient fluorescent lamps , reducing the power consumption , but also reducing the light output and raising the cost . 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 . 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 " type multi @-@ colored advertising signs are often entirely krypton @-@ based) . Krypton is 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 .
The krypton fluoride laser. is important in nuclear fusion energy research in confinement experiments . The laser has high beam uniformity , short wavelength , and the spot size can be

varied to track an imploding pellet .

In experimental particle physics , liquid krypton is used to construct quasi @-@ homogeneous electromagnetic calorimeters . A notable example is the calorimeter of the NA48 experiment at CERN containing about 27 tonnes of liquid krypton . This usage is rare , since liquid argon is less expensive . The advantage of krypton is a smaller Molière radius of 4 @.@ 7 cm , which provides excellent spatial resolution with little overlapping . The other parameters relevant for calorimetry are : 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 (MRI) for imaging airways . In particular , it enables the radiologist to distinguish between hydrophobic and hydrophilic surfaces containing an airway .

Although xenon has potential for use in 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 .

Krypton @-@ 85 in the atmosphere has been used to detect clandestine nuclear fuel reprocessing facilities in North Korea and Pakistan . Those facilities were detected in the early 2000s and were believed to be producing weapons @-@ grade plutonium .

= = Precautions = =

Krypton is considered to be a non @-@ toxic asphyxiant . Krypton has a 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) and could affect anyone breathing it . At the same time , that mixture would contain only 10 % oxygen (rather than the normal 20 %) and hypoxia would be a greater concern .