Noble gas

The **noble gases** (historically also the **inert gases**; sometimes referred to as **aerogens**) make up a group of chemical elements with similar properties; under standard conditions, they are all odorless, colorless, monatomic gases with very low chemical reactivity. The six naturally occurring noble gases are helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and the radioactive radon (Rn). Oganesson (Og) is variously predicted to be a noble gas as well or to break the trend due to relativistic effects; its chemistry has not yet been investigated. The elements in group 18 are the noble gases (helium, neon, argon, krypton, xenon, and radon). They earned the name "noble" because they were assumed to be nonreactive since they have filled valence shells.

These elements are present in the atmosphere in small amounts. Some natural gas contains 1–2% helium by mass. Helium is isolated from natural gas by liquefying the condensable components, leaving only helium as a gas. The United States possesses most of the world's commercial supply of this element in its helium-bearing gas fields. Argon, neon, krypton, and xenon come from the fractional distillation of liquid air. Radon comes from other radioactive elements. More recently, it was observed that this radioactive gas is present in very small amounts in soils and minerals. Its accumulation in well-insulated, tightly sealed buildings, however, constitutes a health hazard, primarily lung cancer.

The boiling points and melting points of the noble gases are extremely low relative to those of other substances of comparable atomic or molecular masses. This is because only weak London dispersion forces are present, and these forces can hold the atoms together only when molecular motion is very slight, as it is at very low temperatures. Helium is the only substance known that does not solidify on cooling at normal pressure. It remains liquid close to absolute zero (0.001 K) at ordinary pressures, but it solidifies under elevated pressure.

Use of Noble gases

Helium is used for filling balloons and lighter-than-air craft because it does not burn, making it safer to use than hydrogen. Helium at high pressures is not a narcotic like nitrogen. Thus, mixtures of oxygen and helium are important for divers working under high pressures. Using a helium-oxygen mixture avoids the disoriented mental state known as nitrogen narcosis, the so-called rapture of the deep. Helium is important as an inert atmosphere for the melting and welding of easily oxidizable metals and for many chemical processes that are sensitive to air.

Liquid helium (boiling point, 4.2 K) is an important coolant to reach the low temperatures necessary for cryogenic research, and it is essential for achieving the low temperatures necessary to produce superconduction in traditional superconducting materials used in powerful magnets and other devices. This cooling ability is necessary for the magnets used for magnetic resonance imaging, a common medical diagnostic procedure. The other common coolant is liquid nitrogen (boiling point, 77 K), which is significantly cheaper.

Neon is a component of neon lamps and signs. Passing an electric spark through a tube containing neon at low pressure generates the familiar red glow of neon. It is possible to change the color of the light by mixing argon or mercury vapor with the neon or by utilizing glass tubes of a special color.

Argon was useful in the manufacture of gas-filled electric light bulbs, where its lower heat conductivity and chemical inertness made it preferable to nitrogen for inhibiting the vaporization of the tungsten filament and prolonging the life of the bulb. Fluorescent tubes commonly contain a mixture of argon and mercury vapor. Argon is the third most abundant gas in dry air.

Krypton-xenon flash tubes are used to take high-speed photographs. An electric discharge through such a tube gives a very intense light that lasts only 150,000 of a second. Krypton forms a difluoride, KrF_2, which is thermally unstable at room temperature.

First xenon compound

A scientist named Neil Bartlett found that PtF_6 reacts with oxygen and forms $O_2^+ [PtF_6]^-$. The ionization energy of oxygen and xenon is comparable, and so PtF_6 should react with xenon to form $Xe^+ [PtF_6]^-$. This assumption was proved to be correct and hence he succeeded in isolating the orange-yellow compound, $XePtF_6$. This compound was obtained at room temperature by the interaction of PtF_6 with xenon. This discovery of Neil Bartlett led to the further discovery of several other xenon compounds, mainly those formed with electronegative elements such as fluorine and oxygen. There are only a few compounds of Krypton. Some compounds of radon have been prepared and identified by radiotracer techniques, but their isolation has not been possible. The true chemical nature of compounds of helium, neon, and argon are still unknown.

Compounds of Xenon and fluorine

Xenon easily combines with fluorine to form xenon fluorides:

(a)XeF_2

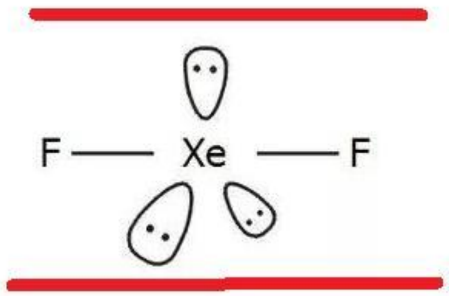
Preparation:

$Xe + F_2 \text{ ---> } XeF_2$

(Xenon) Fluroide XenonFluoride

2 : 1 (catalyst is nickel, 673k and 1 bar)

Structure:



Xenon difluoride

They are readily hydrolysed.

$$2XeF_2(s) + 2H_2O(l) \rightarrow 2Xe(g) + HF(aq) + O_2(g)$$

(b)XeF_4 xenon tetrafluoride

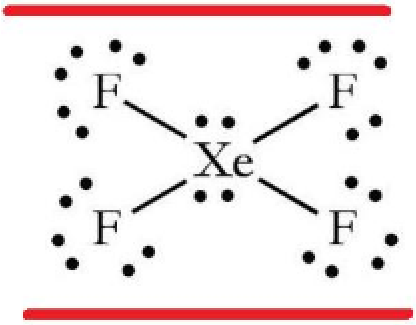
Preparation:

$$Xe + 4F_2 \rightarrow XeF_4$$

xenon flourine xenon tetrafluoride

1 : 5 (catalyst Ni ,temp.373 k ,6-7 bar)

The structure of xenon tetrafluoride is:



Reaction with water:

$$XeF_4 + H_2O \rightarrow Xe + HF + XeO_3 + O_2$$

xenon tetrafluoride water xenon hydrogen fluoride xenon trioxide oxygen gas

temp -80celsius

$$XeF_4 + H_2O \rightarrow HF + XeOF_2$$

xenon tetrafluoride hydrogen fluoride xenon oxyfluoride

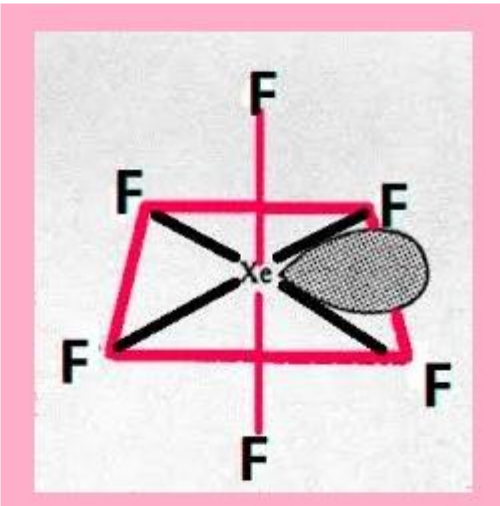
(c) XeF_6 xenon hexafluoride

Preparation:

$$Xe + 3F_2 \rightarrow XeF_6$$

xenon flourine xenon hexafluoride

1: 20(catalyst nickel,temp.573k,60-70 bar)



xenon hexafluoride

Preparation of Xenon-fluorine compounds:

$$Xe(g) + F_2(g) \xrightarrow{673K, 1bar} XeF_2(s)$$
$$(\text{Xenon in excess})$$
$$Xe(g) + 2F_2(g) \xrightarrow{873K, 7bar} XeF_4(s)$$
$$(1:5 \text{ ratio})$$
$$Xe(g) + 3F_2(g) \xrightarrow{573K, 60-70bar} XeF_6(s)$$
$$(1:20 \text{ ratio})$$

They react with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.

$XeF_2 + PF_5 \rightarrow [XeF] + [PF_6]^-$

$XeF_4 + SbF_5 \rightarrow [XeF_3]^+ [SbF_6]^-$

$XeF_6 + MF \rightarrow M^+ [XeF_7]^-$

[Where, M = Na, K, Rb or Cs]

The oxide and oxyfluorides of xenon are obtained from the fluorides. Xenon trioxide can be obtained by the hydrolysis of XeF_4 or XeF_6.

$$2XeF_4 + 3H_2O \rightarrow Xe + XeO_3 + 6HF + F_2$$

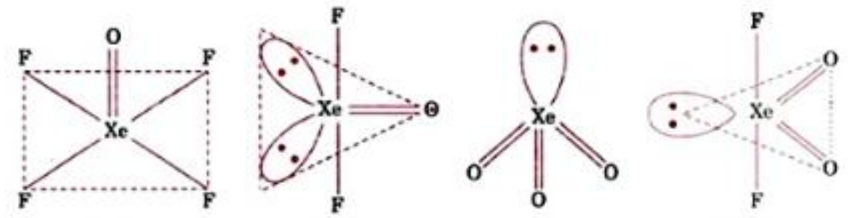
$$XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$$

The oxyfluorides of xenon namely xenon oxydifluoride ($XeOF_2$) and xenon oxytetrafluoride ($XeOF_4$) are also obtained by the partial hydrolysis of XeF_4 and XeF_6 respectively.

$$XeF_4 + H_2O \rightarrow XeOF_2 + 2HF$$

$$XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$$

The structure of these compounds are shown below:



$XeOF_4$ Square pyramidal; $XeOF_2$ T-shaped; XeO_3 Trigonal pyramidal; XeO_2F_2 Distorted trigonal bipyramidal