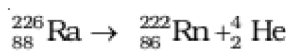


Group 18 Elements

Group 18 consists of six elements: helium, neon, argon, krypton, xenon and radon. All these are gases and chemically unreactive. They form very few compounds. Because of this they are termed noble gases.

Occurence:All the noble gases except radon occur in the atmosphere. Their atmospheric abundance in dry air is ~ 1% by volume of which argon is the major constituent. Helium and sometimes neon are found in minerals of radioactive origin e.g., pitchblende, monazite, cleveite. The main commercial source of helium is natural gas. Xenon and radon are the rarest elements of the group. Radon is obtained as a decay product of ²²⁶Ra.



The important atomic and physical properties of the Group 18 elements along with their electronic configurations are given below:

Electronic Configuration: All noble gases have general electronic configuration ns²np⁶ except helium which has 1s². Many of the properties of noble gases including their inactive nature are ascribed to their closed shell structures.

Ionisation Enthalpy: Due to stable electronic configuration these gases exhibit very high ionisation enthalpy. However, it decreases down the group with increase in atomic size.

Atomic Radii: Atomic radii increase down the group with increase in atomic number.

Electron Gain Enthalpy: Since noble gases have stable electronic configurations, they have no tendency to accept the electron and therefore, have large positive values of electron gain enthalpy.

Physical Properties: All the noble gases are monoatomic. They are colourless, odourless and tasteless. They are sparingly soluble in water. They have very low melting and boiling points because the only type of interatomic interaction in these elements is weak dispersion forces. Helium has the lowest boiling point (4.2 K) of any known substance. It has an unusual property of diffusing through most commonly used laboratory materials such as rubber, glass or plastics.

Chemical Properties: In general, noble gases are least reactive. Their inertness to chemical reactivity is attributed to the following reasons:

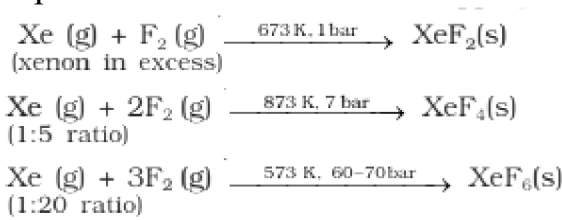
(i) The noble gases except helium (1s²) have completely filled ns²np⁶ electronic configuration in their valence shell.

(ii) They have high ionisation enthalpy and more positive electron gain enthalpy.

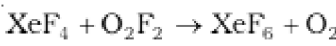
The reactivity of noble gases has been investigated occasionally, ever since their discovery, but all attempts to force them to react to form the compounds, were unsuccessful for quite a few years. In March 1962, Neil Bartlett, then at the University of British Columbia, observed the reaction of a noble gas. First, he prepared a red compound which is formulated as O₂⁺PtF₆⁻. He, then realised that the first ionisation enthalpy of molecular oxygen (1175 kJmol⁻¹) was almost identical with that of xenon (1170 kJ mol⁻¹). He made efforts to prepare same type of compound with Xe and was successful in preparing another red colour compound Xe⁺PtF₆⁻ by mixing PtF₆ and xenon. After this discovery, a number of xenon compounds mainly with most electronegative elements like fluorine and oxygen, have been synthesised.

The compounds of krypton are fewer. Only the difluoride (KrF₂) has been studied in detail. Compounds of radon have not been isolated but only identified (e.g., RnF₂) by radiotracer technique. No true compounds of Ar, Ne or He are yet known.

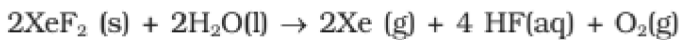
(a) Xenon-fluorine compounds: Xenon forms three binary fluorides, XeF₂, XeF₄ and XeF₆ by the direct reaction of elements under appropriate experimental conditions



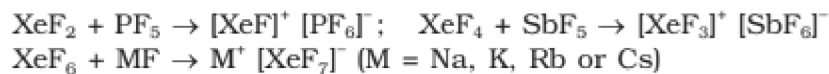
XeF₆ can also be prepared by the interaction of XeF₄ and O₂F₂ at 143K.



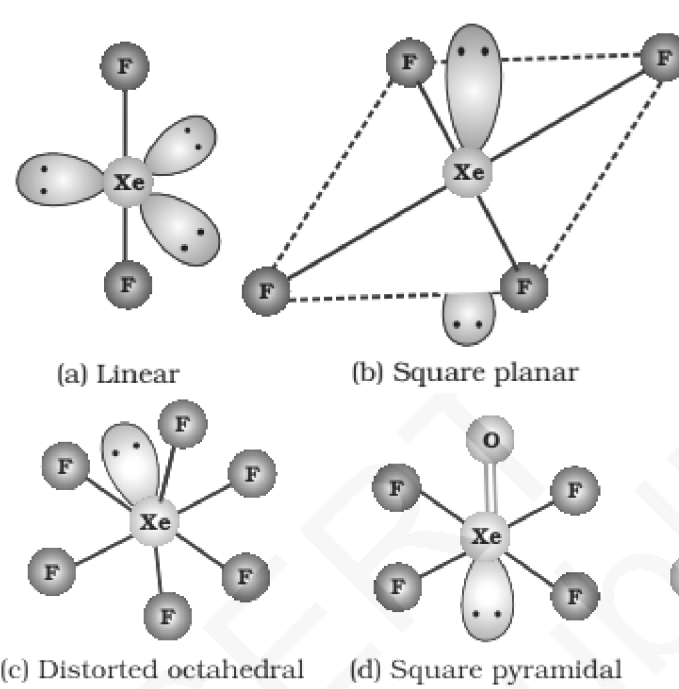
XeF₂, XeF₄ and XeF₆ are colourless crystalline solids and sublime readily at 298 K. They are powerful fluorinating agents. They are readily hydrolysed even by traces of water. For example, XeF₂ is hydrolysed to give Xe, HF and O₂.



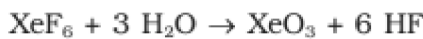
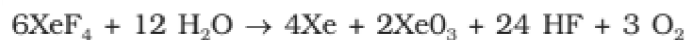
The structures of the three xenon fluorides can be deduced from VSEPR and these are shown in the following Figure. XeF₂ and XeF₄ have linear and square planar structures respectively. XeF₆ has seven electron pairs (6 bonding pairs and one lone pair) and would, thus, have a distorted octahedral structure as found experimentally in the gas phase. Xenon fluorides react with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.



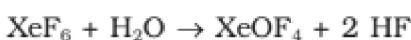
(b) Xenon-oxygen compounds



Hydrolysis of XeF₄ and XeF₆ with water gives XeO₃.



Partial hydrolysis of XeF₆ gives oxyfluorides, XeOF₄ and XeO₂F₂.



XeO₃ is a colourless explosive solid and has a pyramidal molecular structure XeOF₄ is a colourless volatile liquid and has a square pyramidal molecular structure.

Uses: Helium is a non-inflammable and light gas. Hence, it is used in filling balloons for meteorological observations. It is also used in gas-cooled nuclear reactors. Liquid helium (b.p. 4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures. It is used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems for clinical diagnosis. It is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Neon bulbs are used in botanical gardens and in green houses. Argon is used mainly to provide an inert atmosphere in high temperature metallurgical processes (arc welding of metals or alloys) and for filling electric bulbs. It is also used in the laboratory for handling substances that are air-sensitive. There are no significant uses of Xenon and Krypton. They are used in light bulbs designed for special purposes.