Group-18-elements

Element	Atomic No	E.C
He	2	$1s^2$
Ne	10	$2s^2 2p^6$
Ar	18	$3s^2 3p^6$
Kr	36	$4s^2 4p^6$
Xe	54	$5s^2 5p^6$
Rn	86	$6s^2 6p^6$
Og	118	$7s^2 7p^6$

Exept "He" all other have $ns^2 np^6$ – octet

He has $1s^2$.

Noble gases are chemically inert, hence called as inert gases

→ In air they are 1% by volume – aerogens, rare gases.

→ 'Ar' most abundant.

→ by volume Ar > Ne > He > Kr > Xe

→ by mass Ar > Ne > Kr > Xe > He

→ "He" commercially source of He is natural gas.

→ "He" is present in chromosphere of Sun.

→ "He" and "Ne" are present in radioactive ores like monozite, pitchblende, cleveite.

→ $Ra^{226}_{88} \longrightarrow He^{4}_{2} + Rn^{222}_{86}$ on disintegration of Radium

→ Ramsay and Rayleigh introduced noble gases.

General properties:

→ Monoatomic gases → Atomic size He < Ne < Ar < Kr

$\frac{C_p}{C_v} = 1.66$

→ I.P values high. I.P values He to Xe ↓

Kr & Xe have low I.P value

→ E.N = 0

→ Here +ve E.A values — Ne > Ar ≅ Kr > Xe > Rn > He

He	Ne	Ar	Kr	Xe	Rn
46	116	96	96	77	68

→ Only Vander waal's forces are present in them.

→ B.P values He to Xe ↑

→ He has low B.P 4.2k

↓

cooled to 2.2k

He – II

low viscosity, it flows from lower to upper direction.

"He" diffuses into rubber, plastic & glass.

→ Ease of liquification He to Xe ↑

→ Density He to Xe ↑

→ Enthalpy of adsorption He to Xe ↑

→ polarisability He to Xe ↑

→ Diffusion He to Xe ↓

→ Thermal conductivity He to Xe ↓

→ Enthalpy of vaporisation — He to Xe ↑

→ Solubility of in water — He to Xe ↑

→ Chemical reactivity —

Chemically inert — $ns^2 np^6$ octet

"Bartlett" introduced "Xe" comp.

$$Xe^{+}[PtF_6]^{-}$$

Xenon hexa fluroplatinate (V).

$$O_2^{+}[PtF_6]^{-}$$

O_2 & Xe has same I.P values (1175kJ/mol, 1170kJ/mol)

Diameter ~4Å

2/5/23

→ Xenon forms compounds with fluorine

XeF_2, XeF_4, XeF_6

XeO_3, XeO_4

Preparation

$Xe + F_2 \xrightarrow[1\,bar]{673\,K} XeF_2$ (excess)

$Xe + 2F_2 \xrightarrow[6-7\,bar]{873\,K} XeF_4$ (1 : 5)

$Xe + 3F_2 \xrightarrow[60-70\,bar]{573\,K} XeF_6$ (1 : 20)

$2Xe + 2OF_2 \longrightarrow 2XeF_2 + O_2$

Room temp

$Xe + O_2F_2 \xrightarrow[-118°C]{\text{low temp}} XeF_2 + O_2$

$4Xe + 8OF_2 \longrightarrow 2XeF_4 + 2XeOF_4 + 3O_2$

$XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$

XeF_2, XeF_4, XeF_6, colourless, ~~deliquescent~~ crystalline solids.

density order $XeF_2 > XeF_4 > XeF_6$

XeF_2, XeF_4, XeF_6 good fluorinating agents

$XeF_6 > XeF_4 > XeF_2$

$XeF_6 + 8NH_3 \longrightarrow 6NH_4F + N_2 + Xe$

$XeF_4 + SF_4 \longrightarrow SF_6 + Xe$

$XeF_4 + Pt \longrightarrow PtF_4 + Xe$

$XeF_2 + Hg \longrightarrow HgF_2 + Xe$

$XeF_2 + C_2H_4 \longrightarrow C_2H_4F_2 + Xe$

$2NO + XeF_2 \longrightarrow Xe + 2NOF$

XeF_2, XeF_4, XeF_6 good oxidising agent

Oxidising power

$XeF_6 > XeF_4 > XeF_2$

$XeF_6 + 6HCl \longrightarrow 3Cl_2 + 6HF + Xe$

$XeF_4 + 4KI \longrightarrow 2I_2 + 4KF + Xe$

$XeF_2 + 2HCl \longrightarrow Cl_2 + 2HF + Xe$

$XeF_6 + BrO_3^- + H_2O \longrightarrow BrO_4^- + HF + Xe$

Bromate — perbromate

XeF_2 oxidises Ce^{+3} to Ce^{+4}

$XeF_2 + SO_4^{-2} + Ce_2(SO_4)_3 \longrightarrow 2Ce(SO_4)_2 + Xe + F_2$

Hydrolysis:

$2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$

hydrolysis of XeF_4 is disproportionation reaction

$6XeF_4 + 12H_2O \longrightarrow 4XeO_3 + 2Xe + 24HF + 3O_2$

+4 → +6, 0

$XeF_4 \xrightarrow[\text{partial}]{H_2O} XeOF_2 \xrightarrow[\text{complete}]{H_2O} XeO_3$

$XeF_4 + H_2O \longrightarrow XeOF_4 + 2HF$

$XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

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

$XeF_6 \xrightarrow[H_2O]{\text{partial}} XeOF_4 \xrightarrow[2H_2O]{\text{partial}} XeO_2F_2 \xrightarrow[\text{hydrolysis}]{\text{complete}} XeO_3$

$XeF_6 + OH^- \longrightarrow HXeO_4^- \longrightarrow XeO_6^{-4} + Xe + H_2O + O_2$

Xenate ion — peroxenate ion

XeF_6 cannot be stored in glass.

$XeF_6 + SiO_2 \longrightarrow SiF_4 + XeOF_4 \xrightarrow{SiO_2} SiF_4 + XeO_2F_2$

$SiF_4 + XeO_3 \longleftarrow SiO_2$

forms +ve ions with fluoride ion acceptor

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

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

form -ve ions with fluoride ion ~~acceptor~~ donor

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

M = Na, K, Rb, Cs

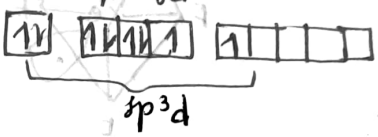
$XeF_6 + CsF \rightarrow Cs^+[XeF_7]^-$

Structure

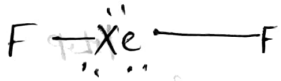
XeF_2 $Xe - sp^3d$

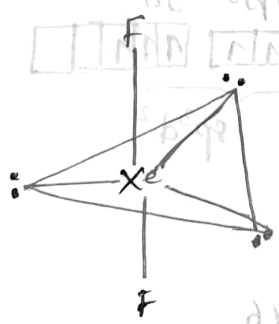
$Xe - 5s^2 5p^6$

1^{st} E. state $- 5s^2 5p^5 5d^1$



3 L.P



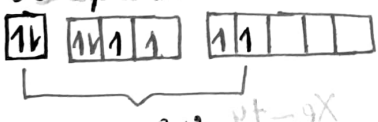


XeF_4

$Xe - sp^3d^2$

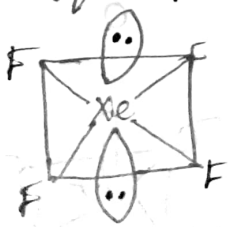
$Xe - 5s^2 5p^6$

2^{nd} E. state $- 5s^2 5p^4 5d^2$



2 L.P

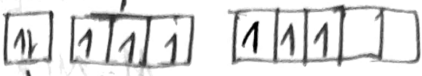
square planar



XeF_6

$Xe - 5s^2\ 5p^6$

3^{rd} E. state - $5s^2\ 5p^3\ 5d^3$



sp^3d^3

1 L.P

Distorted octahedral

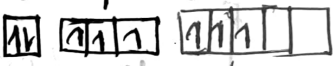
$XeOF_4$

$Xe = +6$

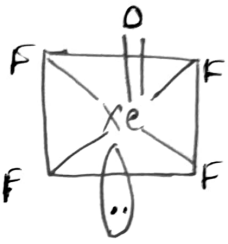
3^{rd} E state

$5s^2\ 5p^3\ 5d^3$

1 L.P



sp^3d^2



1 $d\pi - p\pi$ bond

square pyramidal

XeO_2F_2

$Xe = +6$

$Xe = sp^3d^2$

1 L.P

Seesaw structure

2 $d\pi - p\pi$ bonds

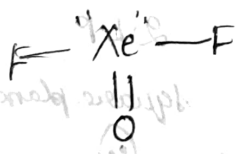
$XeOF_2$

$Xe - +4$

$Xe - sp^3d$

2 L.P

T-shape

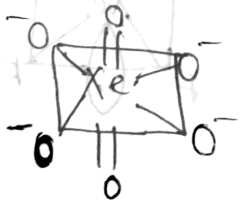


XeO_6^{-4}

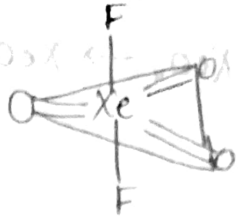
perxenate ion

$Xe - sp^3d^2$

octahedral



XeO_3F_2



Xe + 8

$Xe - sp^3d$

Trigonal bipyramidal

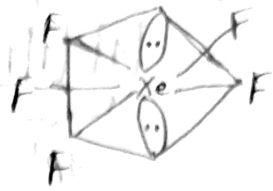
3 dπ - pπ bonds

XeF_5^-

sp^3d^2

2 L.P

pentagonal planar



3|5|2³

XeO_3 +6 O.S

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

$6XeF_4 + 12H_2O \longrightarrow 2XeO_3 + 4Xe + 24HF + 3O_2$

XeO_3 colourless, deliquescent & explosive solid

Unstable Xe and O_2

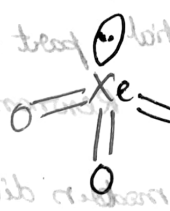
XeO_3 - explosive solid, oxidising agent

$3Pu^{+2} + XeO_3 + 6H^+ \longrightarrow 3Pu^{+4} + Xe + 3H_2O$

$XeO_3 + XeOF_4 \longrightarrow 2XeO_2F_2$

XeO_3

$Xe - sp^3$



1 L.P

pyramidal

3 dπ - pπ bonds

Xe - $5s^2 5p^6$

1st E.S - $5s^2 5p^5 5d^1$

2nd E.S - $5s^2 5p^4 5d^2$

3rd E.S - $5s^2 5p^3 5d^3$

sp^3

XeO_4 +8 O.S

Step I: $XeF_6 + Ba(OH)_2 \longrightarrow Ba_2XeO_6 + BaF_2 + Xe + H_2O + O_2$

Barium perxenate

Step II: $Ba_2XeO_6 + 2H_2SO_4 \longrightarrow 2BaSO_4 + XeO_4 + 2H_2O$ (conc)

XeO_4 Colourless, explosive gas

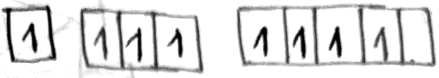
less stable than XeO_3

exploded at low temp - 233K

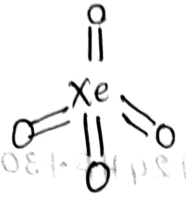
$$XeF_6 + XeO_4 \rightarrow XeO_3F_2 + XeOF_4$$

XeO_4 $Xe - sp^3$

4^{th} E.S - $5s^1\ 5p^3\ 5d^4$



$1P^3$



4 dπ – pπ bonds

No Lps

Tetrahedral

Uses of He:

→ Filling air balloons for meteorological observations.

→ Gas-cooled nuclear reactors.

→ Liquid He finds use as cryogenic agent for carrying out various experiments at low temperature.

→ To produce and sustain powerful superconducting magnet which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI).

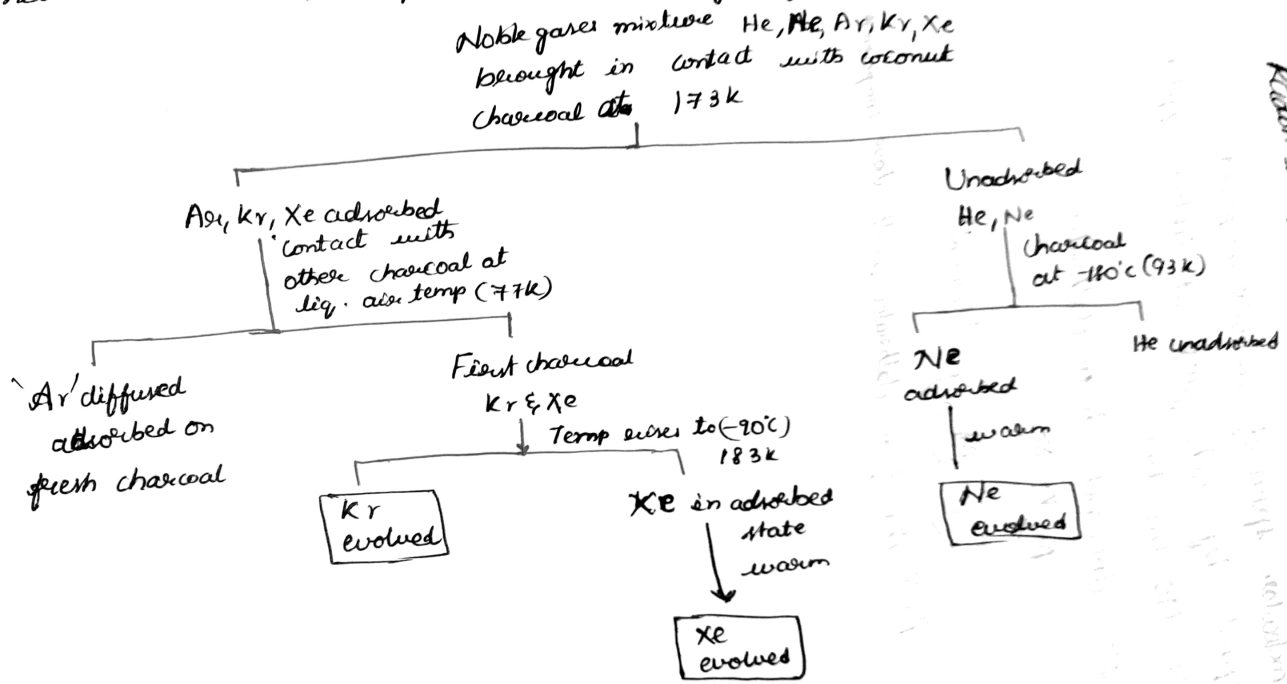
→ As a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

Neon: Used in discharge tubes and fluorescent bulbs. Used in botanical gardens and in green houses.

Argon: Argon is used mainly to provide an inert atmosphere in high temperatures metallurgical process.

→ For electric bulbs, in lab, for handling substances that are air-sensitive.

Dewar's method is used to separate the Noble gas from noble gas mixture



Krypton is used for finding out
Radon is used in radiotherapy, X-ray photography.

→ Quinol, H_2S, SO_2, CH_3OH, CH_3CN, etc forms clathrates with noble gases.

→ Intermolecular spaces of molecular compounds is occupied by noble gases at certain applied pressure (10–40 atm).

→ He & Ne does not form clathrates.

Ar, Xe, Kr forms clathrates with above compounds.