Atomic Energy Central School-3, TARAPUR

- MODULE-4
- Unit : p- block elements
- Chapter : 18- Group elements

p- Block elements

18-
Group
Elements

Introduction

- The 18-Group contains six elements i.e. , helium (He), neon(Ne) , Argon(Ar), kyrpton(Kr), xenon(Xe) and radon(Rn).
- These are called as p- block elements because the last electron enters in the p-subshell of the atom of these elements, except He.
- Since properties of He are quite similar with rest elements, therefore it is kept along them.
- These all are monoatomic gases.
- Except radon, all other gases are present in the atmosphere in very small quantities and hence they are known as rare gases.
- All these gases do not show any chemical reactivity at ordinary temperature and hence earlier called as inert gases.
- They form very few compounds. Because of this they are termed noble gases.

Electronic configuration

The general electronic configuration of noble gases is ns^2np^6 or $ns^2\ np_x^2np_y^2np_z^2$

However He has $1s^2$ configuration.

In these elements orbitals are completely filled by electrons, therefore this electronic configuration is a stable electronic configuration.

occurrence

- 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.
- 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 ^{226}Ra.

^{226}Ra ------- $^{222}Rn + {}^{4}He$

- Helium is the second most abundant element in the universe (23% as compared to 76% hydrogen).

Trends in atomic properties

(i) Ionisation Enthapy : Due to stable electronic configuration these gases exhibit very high

ionisation enthalpy.

However, it decreases down the group with increase in atomic size.

(ii) 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.

Trends in physical properties

- (i) Melting and boiling points : The m.p. and b.p of noble gases are very low(Helium has the

  lowest boiling point (4.2 K) of any known substance), because atoms of these elements are held together by dispersion forces of attraction both in the liquid as well as in the solid states. Further, as we move down the group from He to Rn, the m.p. and b.p. show regular increase due to a corresponding increase in the magnitude of forces of attraction as the size of atom increases.

(ii) Solubility : These gases are slightly soluble in water. Solubility increases from He to Xe.

Trends in chemical properties

The noble gases are chemically inert due to the following reasons.

(a) The noble gases except helium ($1s^2$) have completely filled ns^2np^6 electronic configuration in their valence shell.

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

As we know on moving down the group the ionisation energy decreases. The first ionisation energy of Xe is fairly close to that of O_2 molecule, therefore large number of Xe compounds are known.

The compounds of Kr are fewer. Only KrF_2 has been studied in detail. The compound of Rn (RnF_2) has not been isolated but has only been identified by radiotracer technique.

No true compounds of Ar, Ne or He are yet known.

Compounds of noble gases

Xenon forms three binary fluorides, XeF2, XeF4 and XeF_6 by the direct reaction of elements under appropriate experimental conditions.

Xe (g) + F2 (g) **----->**XeF2(s) (At 1 bar and 673 K)

(xenon in excess)

Xe (g) + 2F2 (g) --------> XeF4(s) (At 7 bar and 873 K)

(1:5 ratio)

Xe (g) + 3F2 (g) ----------> XeF_6(s) (At 60-70 bar and 573 K)

(1:20 ratio)

XeF6 can also be prepared by the interaction of XeF4 & O2F2(s) at 143 K.

XeF4 + O2F2 -----> XeF_6 + O2

Compounds of noble gases

Properties :

- XeF2, XeF4 and XeF6 are colourless crystalline solids and sublime readily at 298 K.
- Fluorides of Xe are powerful fluorinating agents.
- They are readily hydrolysed even by traces of water.

For example, XeF2 is hydrolysed to give Xe, HF and O2.

$2XeF_2 (s) + 2H_2O(l) \rightarrow 2Xe (g) + 4 HF(aq) + O_2(g)$

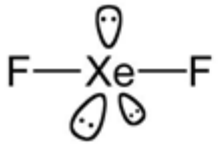
- Xenon fluorides react with fluoride ion acceptors to form cationic

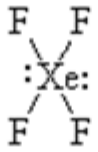
species and fluoride ion donors to form fluoroanions.

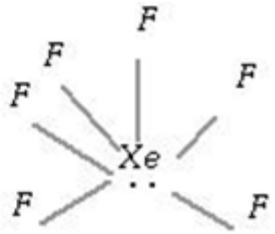
$XeF_2 + PF_5 \rightarrow [XeF]^+ [PF_6]^- ; XeF_4 + SbF_5 \rightarrow [XeF_3]^+ [SbF_6]^-$

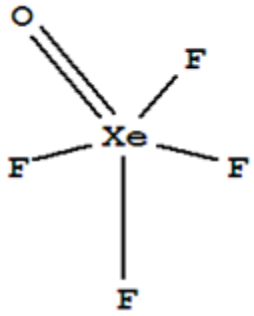
$XeF_6 + MF \rightarrow M^+ [XeF_7]^-$ (M = Na, K, Rb or Cs)

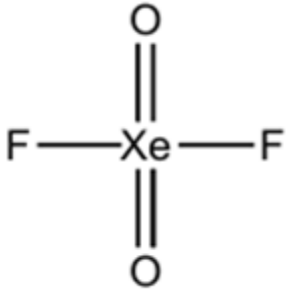
Structures of compounds of Xe.

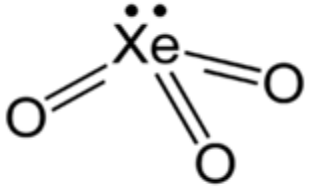












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