

Group VIII - *The Noble Gases*

The elements of Group VIII, the noble gases, are:

	symbol	electron configuration
helium	He	$1s^2$
neon	Ne	$[\text{He}]2s^22p^6$
argon	Ar	$[\text{Ne}]3s^23p^6$
krypton	Kr	$[\text{Ar}]3d^{10}4s^24p^6$
xenon	Xe	$[\text{Kr}]4d^{10}5s^25p^6$
radon	Rn	$[\text{Xe}]4f^{14}5d^{10}6s^26p^6$

Radon is a hazardous radioactive gas and will not be considered further here.

Appearance

As the name suggests, all the elements in this Group are gases.

General Reactivity

These elements are generally considered unreactive, because they have closed-shell configurations.

Occurrence and Extraction

The noble gases are all found in minute quantities in the atmosphere, and are isolated by fractional distillation of liquid air. Helium can be obtained from natural gas wells where it has accumulated as a result of radioactive decay.

Physical Properties

All these gases are monatomic. They boil at low temperatures as only dispersion forces act between the atoms. Helium has the lowest boiling point of any substance at 4.2K.

Atomic radii increase on descending the Group.

Chemical Properties

This Group was originally named the "inert gases", as it was thought they formed no compounds. However, compounds of these gases are now well documented. Helium, neon and argon form no known compounds.

Krypton forms KrF_2 , a colourless solid, on reaction with fluorine.

Xenon forms a wide range of compounds with oxygen and fluorine.

Oxidation States and Ionisation Energies

The 1st ionisation energy decreases on descending the Group, as the valence shell becomes further away from the nucleus and electrons easier to remove. The first ionisation energy of xenon is comparable with that of bromine, which explains why xenon forms compounds with oxygen and fluorine relatively easily. The oxidation numbers of xenon in its compounds are +2, +4, +6 and +8.

Industrial Information

The noble gases do have certain important industrial functions.

Helium is used by divers to dilute the oxygen they breathe.

Argon is widely used to provide an inert atmosphere for high-temperature metallurgical processes.

Neon and argon are used for filling discharge tubes.

Further Information

For further information look up the individual elements.

Data

	Atomic Number	Relative Atomic Mass	Boiling Point/K
He	2	4.003	4.216
Ne	10	20.180	27.10
Ar	18	39.948	87.29
Kr	36	83.80	120.85
Xe	54	131.29	166.1

	1st Ionisation Energy/kJ mol⁻¹	Atomic radius/nm
He	2372.3	0.128
Ne	2080.6	0.160
Ar	1520.4	0.174
Kr	1350.7	0.189
Xe	1170.4	0.218