

Quadrant II – Transcript

Programme: Bachelor of Science (T. Y. B. Sc.)
Subject: Chemistry
Paper Code: CHC 106
Paper Title: Inorganic Chemistry - Section A
Unit: 1 - Periodicity of Elements
Module Name: Atomic Radii and Ionic Radii – PART 3
Module No: 03
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Hello everyone, welcome to this module in inorganic Chemistry - Section A.
The paper code is CHC 106.
The unit title is Periodicity of Elements - Atomic radii and ionic radii Part 3
And the module number is 03.

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The outline of the study, metallic radius, van der Waal's radius and comparative study of van der Waal's radius with covalent radius.

Learning outcomes ; Description of the metallic radius, Operational concepts of van der Waal's radii, Calculation of van der Waal's radius .

Let us begin with Metallic radius, which is also called as Crystal radius and is designated as r_M

In a metal, a large number of atoms are closely packed and are held together by metallic bonds. This close packing of Metallic Atoms is called as metallic lattice or crystal lattice. Thus the metallic radius is a radius of an atom that is bonded with another metallic atom and is calculated by the relation **half internuclear distance** between the nuclei of two metal atoms.

As we see in the diagram, the two metal atoms are just connected at the boundaries. And the distance between the two nuclei is referred as internuclear distance, and half the internuclear distance is the metallic radius.

Metallic radii are larger and weaker than the corresponding single bond covalent radii for the same element, which is smaller and much stronger. This is because the metal atoms in the metallic lattice are not close to each other, and also they do not overlap, as it happens in covalent bond.

For example, we see in this figure the metallic radius of sodium is 186 picometers whereas the covalent radius of sodium is 154 picometers. When sodium forms an ionic compound, its radius further decreases which is 95 picometers.

We move to van der Waal's radius written as r_w .

The van der Waal's radius is defined as half the internuclear distance between the nucleus and atoms belonging to two nearest neighboring molecules of the same substance in the solid state.

That is, it occurs between non covalently bonded atoms. Here we can see two covalent molecules,

molecule one and molecule two, and there's a close interaction between them and the distance from the nucleus of this two non bonded atoms is referred as van der Waal's diameter .

Half the distance of van der Waal's diameter is called as Van der Waal's radius and thus van der Waal's radius is calculated as half the internuclear distance between the two non bonded nearest neighboring atoms from which we calculate the van der Waal's radius of chlorine atom in the molecule Cl_2 . The internuclear distance between two Chlorine atoms of two nearest neighboring Cl_2 molecules is 360 picometers and thus the van der Waal's is half of 360 which is 180 picometers.

In the figure we see two chlorine molecules which are close interaction.

The van der Waal's radii are larger and weaker than the covalent radii in a covalent bond. The atoms come close to each other and overlap, but in van der Waal's bonding the atoms are at a larger distance from each other and thus the forces existing between the non bonded atoms are weaker.

In the following diagram we see there are covalent molecules which are close in interaction with another covalent molecule. There is overlapping of orbitals in the covalent molecule and thus the radius is very small. But when there is an interaction of the two molecules there is wonder wise force which is very weak and the radius is large.

In this table we shall see the van der Waal's radii and the covalent radii of some of the elements and we can see for each of the elements the covalent radius is much smaller in comparison to the van der Waal's radii.

For example, van der Waal's radii for hydrogen is 1.20, whereas the covalent radius for Hydrogen is much smaller, which is point thirty seven(0.37) picometers.

The covalent and van der Waal's radii are applied only for covalent compounds.

van der Waal's radii do not apply to metals.

van der Waal's radii is not a fixed quantity and depends on the effective packing size.

van der Waal's radii and Noble gases:

We see the size of noble gases is much larger than halogens. Which is not actually expected, and this is because the atoms of noble gas in solid state are linked together

by weak van der Waal's forces, while atoms of halogens are bonded by strong covalent forces.

In figure six we see the halogen atoms bonded by a covalent radius or covalent bond, whereas the Noble gas atoms are far apart and the interaction between them is one of the van der Waal's forces.

And thus the noble gas atoms are larger than covalent molecules.

van der Waal's radii and Noble Gases.

The van der Waal's radii and covalent radii of halogens and noble gases is given in Table 2.

The halogens, fluorine, chlorine, bromine and iodine have covalent radii of 64, 99, 114 and 133 picometers, whereas for noble gases, the van der Waal's radii is 131, 175, 189 and 209 which is much larger than the covalent radii of halogen.

For further reading we can refer the following books.

Some of the books are Principles of Inorganic Chemistry by Puri, Sharma and Kalia. Albert, Cotton and Wilkinson for Basic inorganic chemistry.

We can also refer to Inorganic Chemistry by Shriver, and Atkins.

There is another book Inorganic Chemistry by Satyaprakash Tuli and Basu and we have another book Chemistry for Degree Students by Madan R. L.

Thank you.