

Answer on Question#38832-Chemistry-Inorganic Chemistry

Question

My question has to do with the orbitals that contain valence electrons. The definition given in the textbook of an orbital includes that there may be only "2" electrons in an orbital at one time. Later it states how valence electrons are the electrons that are the electrons located in the outermost orbital (Is there a specific name for the outermost orbital? Or is that just what you call it). But shown in examples are orbitals of valence electrons containing more than 2 electrons (usually they are receiving even more valence electrons from another atom) I have seen examples where there are up to 8 electrons in the valence orbital. How can this be if by definition an orbital may only contain 2 electrons at a single time?

Answer

It is quite right that a single orbital can include no more than 2 electrons. Actually, it can include 1 or 2 electrons (sometimes an orbital without electrons is considered as a "vacant orbital" but it is only a speculative term and there is no orbitals without electrons in reality).

It is also quite right that valence electrons are the electrons located in the outermost orbital (or orbitals!). There is no specific name for the outermost orbital.

If an atom has only one outermost orbital (elements of s-block: alkaline and alkaline-earth metals, hydrogen and helium) it contains 1 (hydrogen and alkaline metals) or 2 (helium and alkaline-earth metals) valence electrons, e.g.:

H $1s^1$, Na $1s^2 2s^2 2p^6 3s^1$ (1 valence electron)

He $1s^2$, Mg $1s^2 2s^2 2p^6 3s^2$ (2 valence electrons)

But it is important to realize that an **atom may have more than one outermost orbitals**. For example, the elements of p-block (all non-metals as well as Al, Ga, In, Tl, Ge, Sn, Pb, Bi and Po) have 4 outermost orbitals at most: one s-orbital and three p-orbitals. Each of these 4 orbitals can include two electrons (8 electrons at most). Thus, the number of valence electrons for such elements varies from 3 to 8, e.g.:

B $1s^2 2s^2 2p^1$ (3 valence electrons)

F $1s^2 2s^2 2p^5$ (7 valence electrons)

Ne $1s^2 2s^2 2p^6$ (8 valence electrons)

The elements of d-block (Sc – Zn, Y – Cd, Lu – Hg and all after Hf inclusively) have 9 outermost orbitals at most: 1 s-orbital, 3 p-orbitals and 5 d-orbitals (18 electrons at most), and the elements of f-block (lanthanides and actinides) have 16 outermost orbitals at most: 1 s-orbital, 3 p-orbitals and 5 d-orbitals and 7 f-orbitals (32 electrons at most).