

Section 2: Foundations

The shell model of the atom is a good start in understanding the differences in the chemical properties of the atoms of different elements. For example, we can understand the periodicity of chemical and physical properties from our model, since elements in the same group have the same number of electrons in the valence shell.

However, there are many details missing from our description. Other than a very crude calculation of "distance" of the shells from the nucleus, we have no description of what the differences are between the electrons in different shells. What precisely is a "shell?"

Most importantly, the arrangement of elements into groups and the periodicity of chemical properties both depend on the concept that a shell is "filled" by a certain number of electrons. Looking at the number of elements in each period, the number of electrons which fills a shell depends on which shell is being filled. In some cases, a shell is filled by eight electrons, in others, it appears to be 18 electrons. What determines how many electrons can "fit" in a shell? Why is there a limit at all?

Finally, a closer look at the ionization energies here reveals that our shell model must be incomplete. Our model implies that the elements of the second period from Lithium to Neon have their valence electrons in the second shell. With increasing nuclear charge, the ionization energy of these atoms should increase from Lithium to Neon. As a general trend, this is true, but there are variations. Note that the ionization energy of Oxygen atoms is less than that of Nitrogen atoms. We need to pursue additional detail in our model of the structure of the atom.

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