Electron Arrangement - The Bohr model

Electron Shells

Niels Bohr proposed an early model of the atom as a central nucleus containing protons and neutrons being orbited by electrons in shells. As previously discussed, there is a connection between the number of protons in an element, the atomic number that distinguishes one element from another, and the number of electrons it has. In all electrically-neutral atoms, the number of electrons is the same as the number of protons. Each element, when electrically neutral, has a number of electrons equal to its atomic number.

An early model of the atom was developed in 1913 by Danish scientist Niels Bohr (1885–1962). The Bohr model shows the atom as a central nucleus containing protons and neutrons with the electrons in circular orbitals at specific distances from the nucleus (Figure 1. These orbits form electron shells or energy levels, which are a way of visualizing the number of electrons in the various shells.

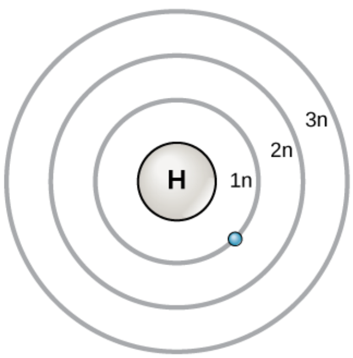

Figure 1: The Bohr model postulated that electron orbited the nucleus in shells of fixed distance.

An electron normally exists in the lowest energy shell available, which is the one closest to the nucleus. Energy from a photon of light can bump it up to a higher energy shell, but this situation is unstable and the electron quickly decays back to the ground state.

Bohr Diagrams

Bohr diagrams show electrons orbiting the nucleus of an atom somewhat like planets orbit around the sun. In the Bohr model, electrons are pictured as traveling in circles at different shells, depending on which element you have. Figure 2 contrast the Bohr diagrams for lithium, fluorine and aluminum atoms.

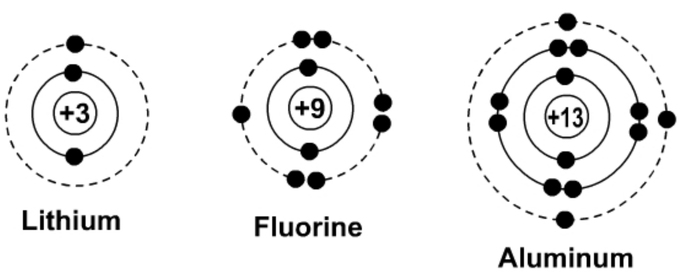

Figure2: Bohr diagrams for neutral lithium, fluorine and aluminum atoms.

Each shell can only hold certain number of electrons before it is full and any extra electrons have to be in another outermost shell.

Lithium has three electrons:

two go to 1st shell and the remaining one goes to the 2nd shell.

Its electron arrangement is 2,1

Fluorine has nine electrons:

two go to 1st shell and the remaining seven go to the 2nd shell.

Its electronic arrangement is 2,7.

Aluminum has thirteen electrons:

2 go to the 1st shell, 8 go to the 2nd shell, and remaining 3 go to the 3rd shell.

Its electronic arrangement is 2,8,3.

Bohr diagrams

Electrons fill orbit shells in a consistent order. Under standard conditions, atoms fill the inner shells (closer to the nucleus) first, often resulting in a variable number of electrons in the outermost shell. The innermost shell has a maximum of two electrons, but the next two electron shells can each have a maximum of eight electrons. Examples of some neutral atoms and their electron configurations are shown in Figure 3.

Bohr diagrams indicate how many electrons fill each principal shell. Group 18 elements (helium, neon, and argon are shown) have a full outer, or valence, shell. A full valence shell is the **most stable** electron configuration. Elements in other groups have partially-filled valence shells and gain or lose electrons to achieve a stable electron configuration.

An atom may gain or lose electrons to achieve a full valence shell, the most stable electron configuration. The organisation of the periodic table is arranged in columns and rows which reflects on the number of electrons and where these electrons are located, providing a tool to understand how electrons are distributed in the outer shell of an atom. As shown in , the group 18 atoms helium (He), neon (Ne), and argon (Ar) all have filled outer electron shells, making it unnecessary for them to gain or lose electrons to attain stability; they are highly stable as single atoms. Their non-reactivity has resulted in their being named the inert gases (or noble gases). In comparison, the group 1 elements, including hydrogen (H), lithium (Li), and sodium (Na), all have one electron in their outermost shells. This means that they can achieve a stable configuration and a filled outer shell by donating or losing an electron. As a result of losing a negatively-charged electron, they become positively-charged ions. When an atom loses an electron to become a positively-charged ion, this is indicated by a plus sign after the element symbol; for example, Na+. Group 17 elements, including fluorine and chlorine, have seven electrons in their outermost shells; they tend to fill this shell by gaining an electron from other atoms, making them negatively-charged ions. When an atom gains an electron to become a negatively-charged ion this is indicated by a minus sign after the element symbol; for example, F-. Thus, the columns of the periodic table represent the similarity of these elements' outer electron shells that is responsible for their similar chemical characteristics.

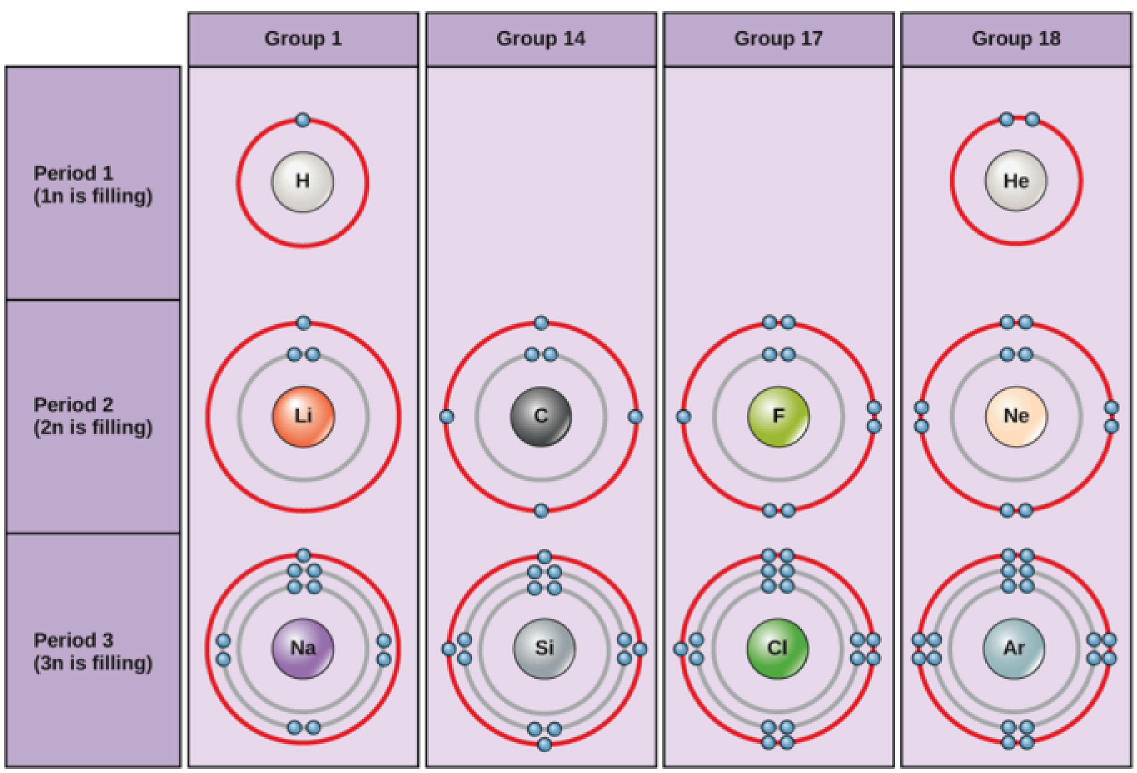

Figure 3: