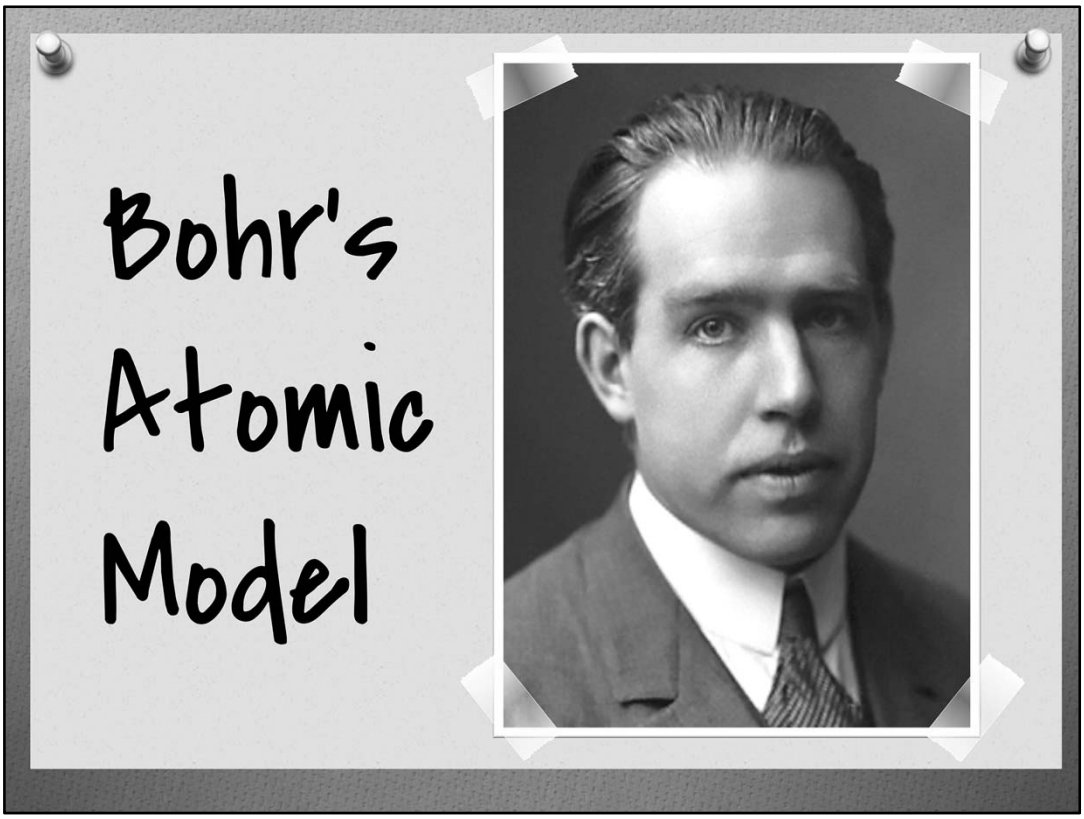
Module 3: Modern Atomic Theory, Electron Structure, and Periodicity
Topic 2 Content: Bohr's Atomic Model Presentation Notes



Bohr's Atomic Model

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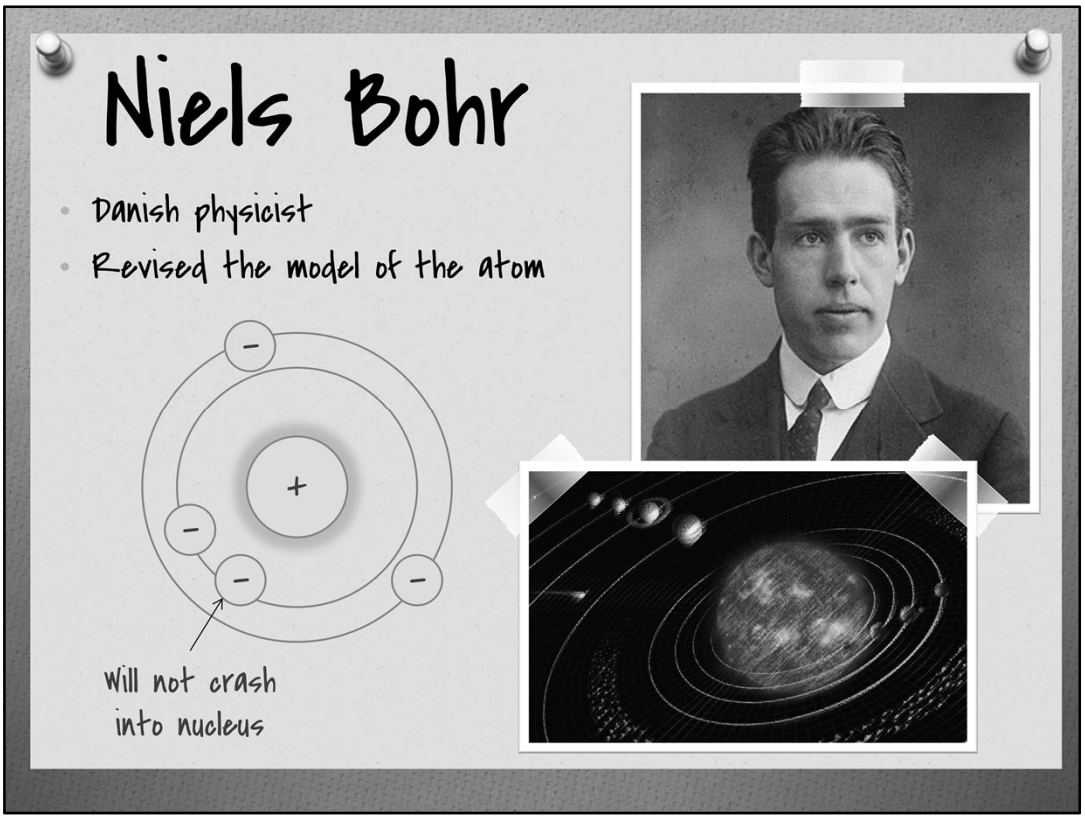
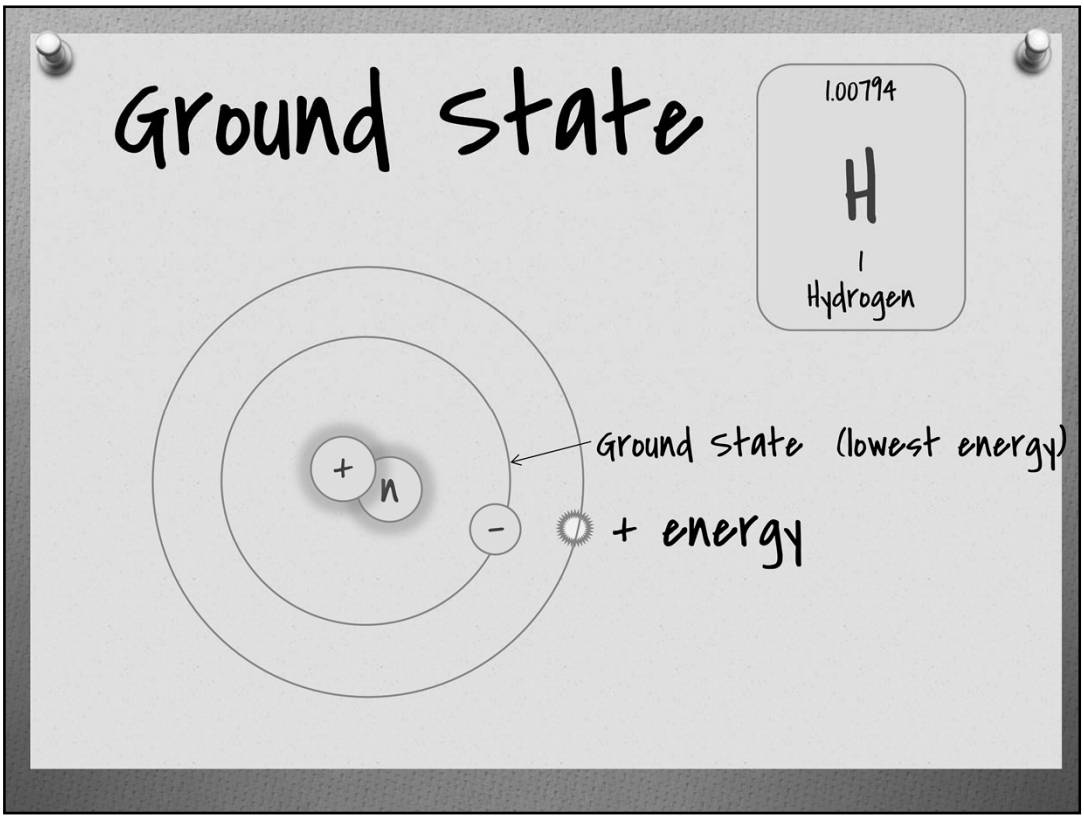
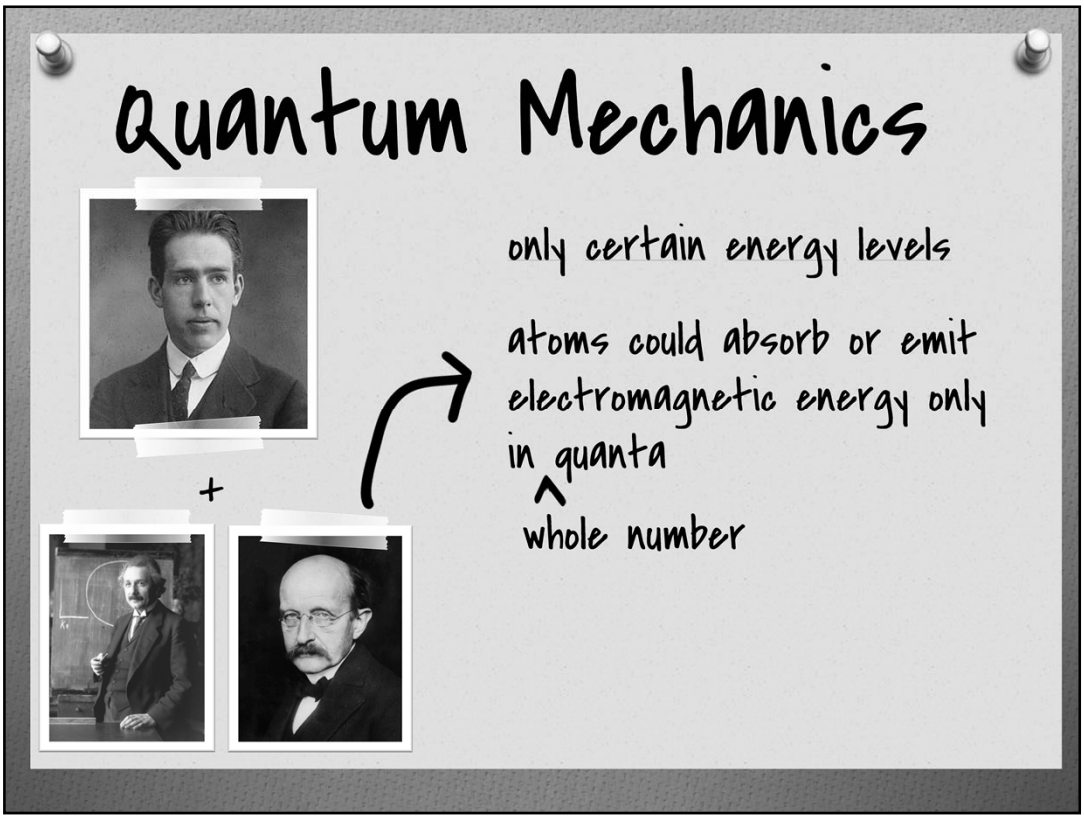


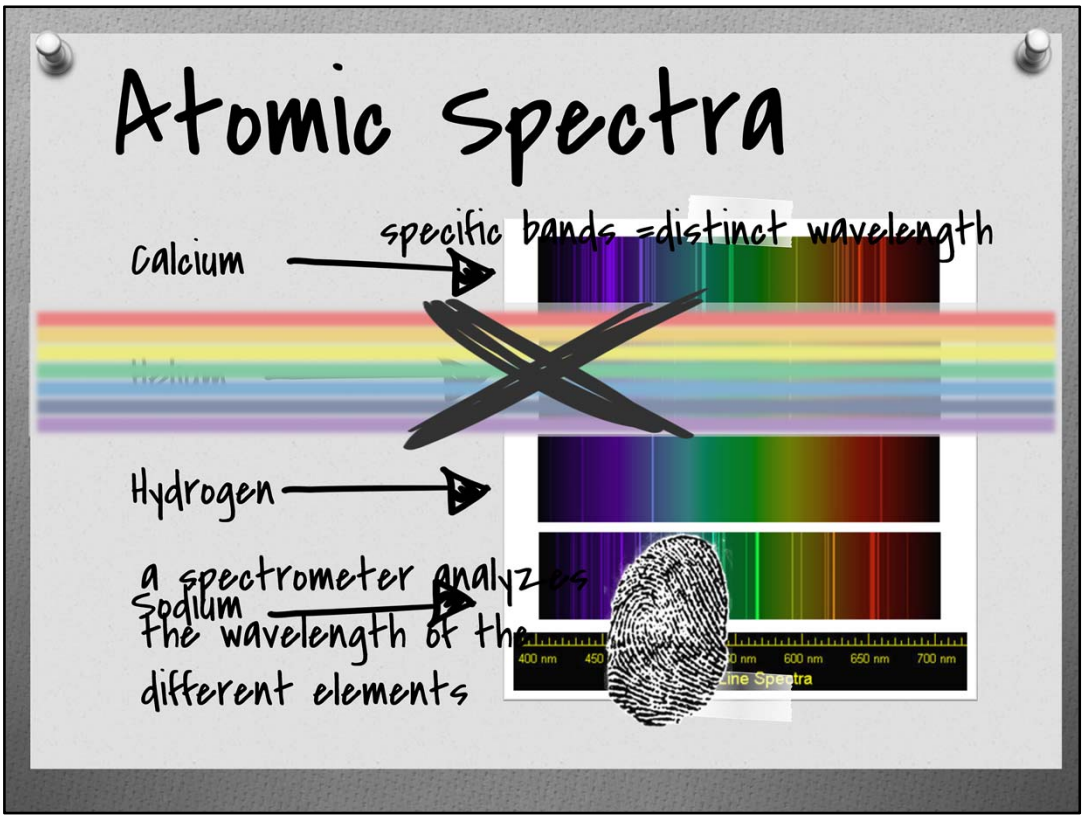
Niels Bohr was an early 20th century physicist with many accomplishments; however, he is best known for revising the model of the atom. Bohr developed a model of the atom that was different than Ernest J. Rutherford's and J.J. Thomson's models. Like Rutherford's model, Bohr's model of the atom had the positive charges centralized in the nucleus and the electrons outside of the nucleus. Unlike Rutherford's model, the electrons could not be found just anywhere outside of the nucleus. Instead, Bohr explained that the electrons were found at specific distances from the nucleus in what he called energy levels. His model operated like the solar system with the negatively-charged electron "planets" orbiting around a positively-charged nucleus "Sun." His model helped to explain why the electrons did not crash into the positive nucleus. The electrons were moving with sufficient energy to maintain a position on the energy level.



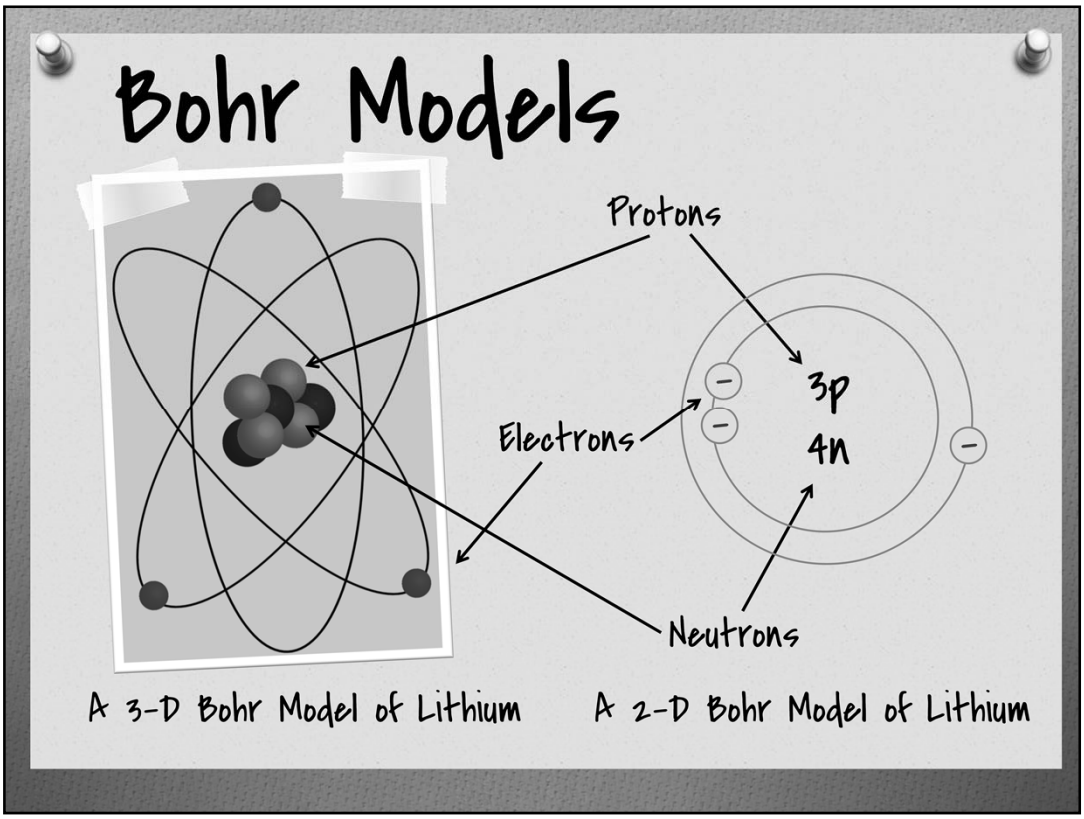
Bohr developed his model by looking at the simplest element, hydrogen. Hydrogen has one proton and one electron. Ordinarily, the electron within a hydrogen atom is at its lowest energy state. This is known as its "ground state." When enough energy is absorbed, the electron is able to move to a higher energy state. Upon returning to its ground state, a photon of light is emitted.



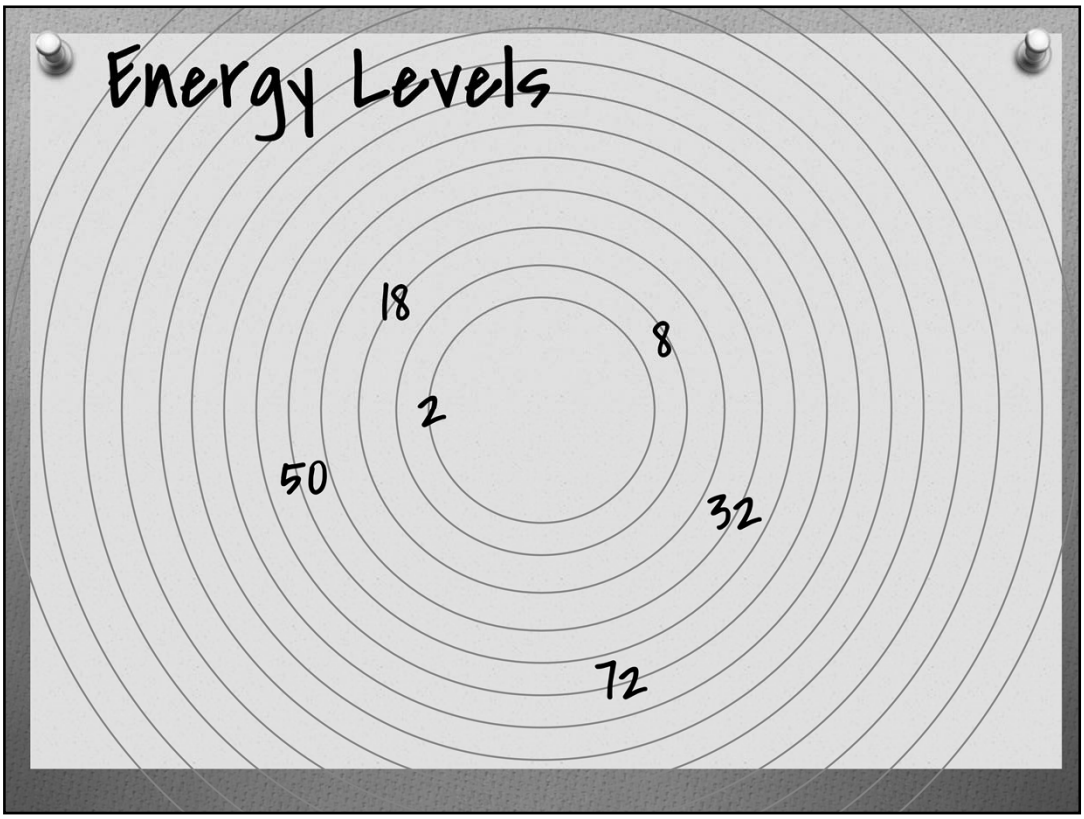
According to Bohr, the electrons existed only within certain energy levels and not in between. His proposal was based on previous work in classical physics and quantum mechanics. Albert Einstein and Max Planck had both developed revolutionary modifications to how scientists viewed light. Planck studied the relationship between energy and frequency and proposed that atoms could absorb or emit electromagnetic energy only in certain discrete amounts. The smallest "packet of light energy" is called a quantum. According to his proposal, energy can be absorbed or emitted in whole number quantum. Energy could not be absorbed or emitted in fractional portions of quantum.



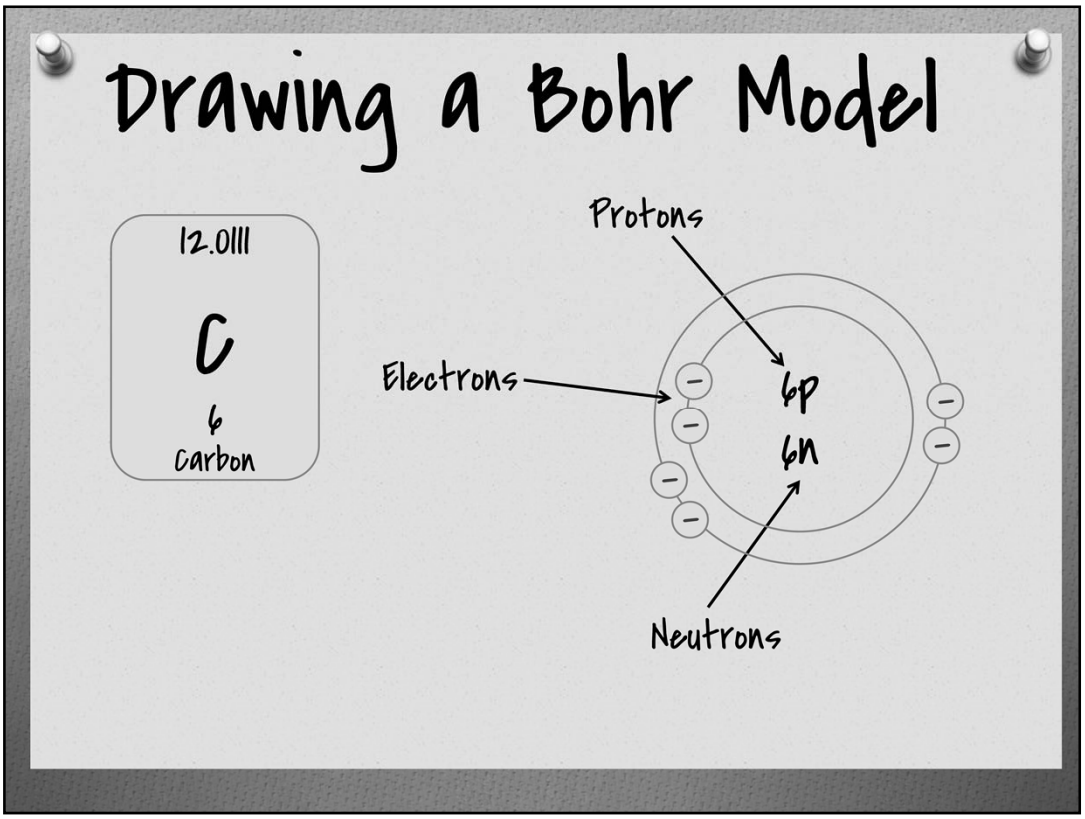
The light spectrum emitted by an atom is not the full visible spectrum. Specific bands correspond with a distinct wavelength. If the electrons were able to exist anywhere outside of the nucleus, then there would be a continuous spectrum emitted when electrons fell back to ground state. The entire rainbow would be visible. Each element produces a unique spectra of light. Scientist can use a spectrometer to analyze the different elements, and the spectral lines identify the different elements like a fingerprint. The image shows the spectra lines produced by the elements calcium, helium, hydrogen, and sodium. You can see how the spectral lines are arranged differently in each.



Based on Niels Bohr's studies of the spectral lines of elements, the atomic model was modified to include the energy levels. Simple models of the atom now included the nucleus with the protons and neutrons and the energy levels with the electrons. Bohr models are drawn similar to the images shown here. Generally, the two dimensional Bohr model is used by students. Notice that the numbers of protons and neutrons are noted in the center where the nucleus is located. In lithium, there are three protons and four neutrons. Then, in the ground state, two electrons are located on the first energy level. There is only one electron located in the second energy level.



There are infinite numbers of energy levels, but at ground state the known elements only use seven energy levels. Energy levels hold a certain number of electrons each. Level one has an electron capacity of two electrons. Level two has a capacity of eight electrons. Level three has a capacity of eighteen electrons. Levels four, five, and six have capacities of thirty-two, fifty, and seventy-two respectively. Keep in mind that every level many not be completely filled before electrons begin to fill the next level. You should always check an element's electron configuration to know how many electrons are in each level.



This example will show you how to draw a Bohr model for the element carbon. Start by writing the number of protons and the number of neutrons in the nucleus. Carbon has six protons and six neutrons. Next, draw the first energy level. Add two electrons to this level since in the element carbon this energy level is filled. After you have drawn the two electrons, draw a second energy level. Since carbon is stable it has four remaining electrons. Draw the four remaining electrons on the second energy level. Now you have completed the Bohr model for carbon.