# Bohr Theory

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**Introduction** Bohr theory is a theory of the structure of atoms stating that electrons revolve in discrete orbits around a positively charged nucleus and that radiation is given off or absorbed only when an electron moves from one orbit to another.

# 1 Bohr's Hydrogen Atom

Niels Bohr introduced the atomic Hydrogen model in 1913. He described it as a positively charged nucleus, comprised of protons and neutrons, surrounded by a negatively charged electron cloud. In the model, electrons orbit the nucleus in atomic shells. The atom is held together by electrostatic forces between the positive nucleus and negative surroundings.

## 1.1 Hydrogen Energy Levels

The Bohr model is used to describe the structure of hydrogen energy levels.

## 1.2 Hydrogen Spectrum

The movement of electrons between these energy levels produces a spectrum. The Balmer equation is used to describe the four different wavelengths of Hydrogen which are present in the visible light spectrum. These wavelengths are at 656, 486, 434, and 410nm. These correspond to the emission of photons as an electron in an excited state transitions down to energy level n=2. The Rydberg formula, below, generalizes the Balmer series for all energy level transitions. To get the Balmer lines, the Rydberg formula is used with an nf of 2.

## 1.3 Rydberg Formula

The Rydberg formula explains the different energies of transition that occur between energy levels. When an electron moves from a higher energy

level to a lower one, a photon is emitted. The Hydrogen atom can emit different wavelengths of light depending on the initial and final energy levels of the transition. It emits a photon with energy equal to the difference of square of the final $(n_f)$ and initial $(n_i)$ energy levels.

$$Energy = R(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

The energy of a photon is equal to Planck's constant, h=6.626*10-34m2kg/s, times the speed of light in a vacuum, divided by the wavelength of emission.

$$E = \frac{hc}{\lambda}$$

Combining these two equations produces the Rydberg Formula.

$$\frac{1}{\lambda} = R(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

The Rydberg Constant (R) $= 10{,}973{,}731.6 \ m^{-1} or 1.097 \times 10^7 \ m^{-1}$

## 1.4 Bohr's postulates

Niels Bohr suggested that the problem about hydrogen spectrum can be solved if we can make some assumptions. According to classical theory, the frequency of the electromagnetic waves emitted by a revolving electron is equal to the frequency of revolution. As the electrons radiate energy, their angular velocities would change continuously and they would emit a continuous spectrum against line spectrum actually observed. So, Bohr concluded that even if electromagnetic theory successfully explained the macroscopic phenomenon, it could not be applied to explain microscopic phenomenon, that in atomic scale. So he made bold suggestions called as Bohr's postulates.