ELECTRONIC STRUCTURE OF THE ATOM

In Rutherford's Model of Atomic Structure, the electrons moved in orbits around the nucleus and were held in their orbits around the nucleus and were held in their orbits by electrostatic attraction to the positively charged nucleus. This attraction varied inversely as the square of the distance between the nucleus and the electron. There was, however, one contradiction to this theory. According to *Classical Electromagnetic Theory*, an accelerating electrical charge must radiate energy. Thus, an electron moving in an orbit around a nucleus must radiate energy and move in a decreasing spiral path until it finally disappears into the nucleus. But this does not happen according to Rutherford's Model.

Further developments in atomic structure had to depend on advances in physics—on the nature of light, the Quantum Theory and the interpretation of atomic emission spectra.

Niel Bohr's Model.

In 1913, Niels Bohr used the Quantum Theory idea developed by Planck and Einstein to account for the spectrum of hydrogen. He made the following assumptions:

1. Rutherford's model of the atom is basically correct.
2. Each spectral line is caused by an electron
3. Electrons can exist only in circular orbits of definite quantum energy
4. An electron emits energy in the form of radiation when it moves from higher to a lower permitted orbit – this produces a line in the atomic emission spectrum. Since the energies of the higher and lower orbits are fixed, the line will be of a particular energy and frequency.
5. The difference in energy, ΔE, of the two orbits is related to the frequency of radiation given by Plank's equation:

$$En_2 = En_2 - En_1$$

Where En_1 is a state with a lower energy level compared to En_2.

Wave Mechanics Model

The Bohr's Model of the atom was able to predict the observed spectral lines of hydrogen with great accuracy, it had to be modified to account for the spectrum of more complicated atoms. Bohr's model has now been replaced by the Wave Mechanics Model.

The Wave Mechanics Model assumes that electrons show wave-like properties. The wave like properties of the electron make it very elusive. This led Heisenberg (in 1927) to postulate the famous *Uncertainty Principle*. According to this principle, if we measure the momentum of an electron accurately, then we cannot know its position with certainty and vice versa.

According to Bohr, the electron was restricted to certain energy levels and was thought to move along certain circular orbits around the nucleus. These energy levels were identified by means of principal quantum number, n. The Wave Mechanics Model of the atom does not restrict the electrons to certain energy levels only. Instead, it describes a region around the nucleus called an *orbital* where there is a possibility of finding an electron with a certain amount of energy (that is given by a wave function). The orbital is identified by a set of three quantum numbers. According to the postulates of Wave Mechanics, the energy levels are composed of one or more orbitals and the distribution of electrons around the nucleus is determined by the number and kind of energy levels that are occupied. Therefore, to predict how electrons are arranged in space, we have to examine levels in the atom.