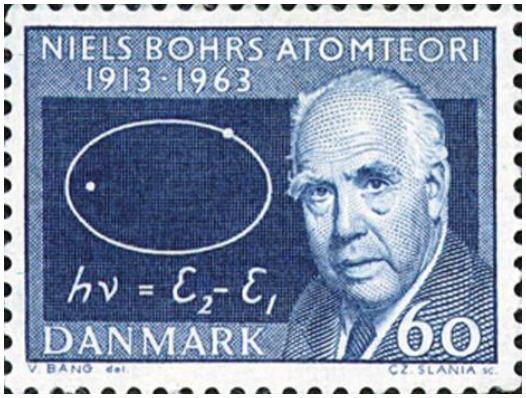
Revising the Bohr Theory of the Atom

What are the key points that I should know about this topic?

The most important point to remember about this topic is that you must be able to clearly explain how the idea of energy levels is linked to emission spectra. The key points may be summarised as follows:



- Electrons revolve around the nucleus in fixed paths called orbits. Electrons in any one orbit have a fixed amount of energy. Orbits are also called energy levels.
- As long as an electron is in any one particular energy level, it neither gains nor loses energy.
- Atoms normally exist in the ground state, i.e. the electrons have the lowest amount of energy possible because they occupy the lowest energy levels available. For example, in the ground state of hydrogen, the electron is in the lowest energy state (n = 1 energy level).
- Electrons in the ground state have energy of fixed values, i.e. the energy of the electrons in a particular orbit or energy level is quantised.
- If energy is provided to an atom in its ground state, a specific amount of this energy is absorbed and the electrons jump to higher levels, i.e. an excited state. For example, in the case of hydrogen, the electrons of the many atoms of hydrogen present, move into higher energy level where n is greater than 1.
- The energy absorbed is equal to the energy difference between the lower energy level (ground state) and a higher energy level (excited state).
- This excited state is unstable and the electrons fall back down to lower energy levels.
- As an electrons falls back, the excess energy is released in the form of light of a definite amount of energy, i.e. light of a definite frequency (wavelength).
- Since only definite amounts of energy are emitted, this implies that electrons can occupy only definite energy levels.
- The frequency of the light emitted depends on the difference in energy between the levels and is given by the equation $E_2 – E_1 = hf$. Therefore a line emission spectrum is obtained.
- E_2 represents the energy of the higher level and E_1 represents the energy of the lower level. The equation $E_2 – E_1 = hf$ tells us that the energy difference is proportional to the frequency. Each element has a unique emission line spectrum because each element has a different number of electrons and has its own arrangement of these electrons in energy levels, i.e. different electron configurations. Therefore, the different electron transitions give rise to different emission spectra.

As well as the above key points, in 2010 students were asked to state two limitations of the Bohr Theory.

The two limitations are:

- The Bohr Theory worked perfectly to explain the emission spectrum of hydrogen but did not work for atoms with more than one electron.

- The Bohr Theory did not take into account the fact that the electron had a wave motion. Therefore, the picture of it travelling in a precise path at a precise distance from the nucleus cannot be true, i.e. we can only refer to the probability of finding an electron in a region in space.

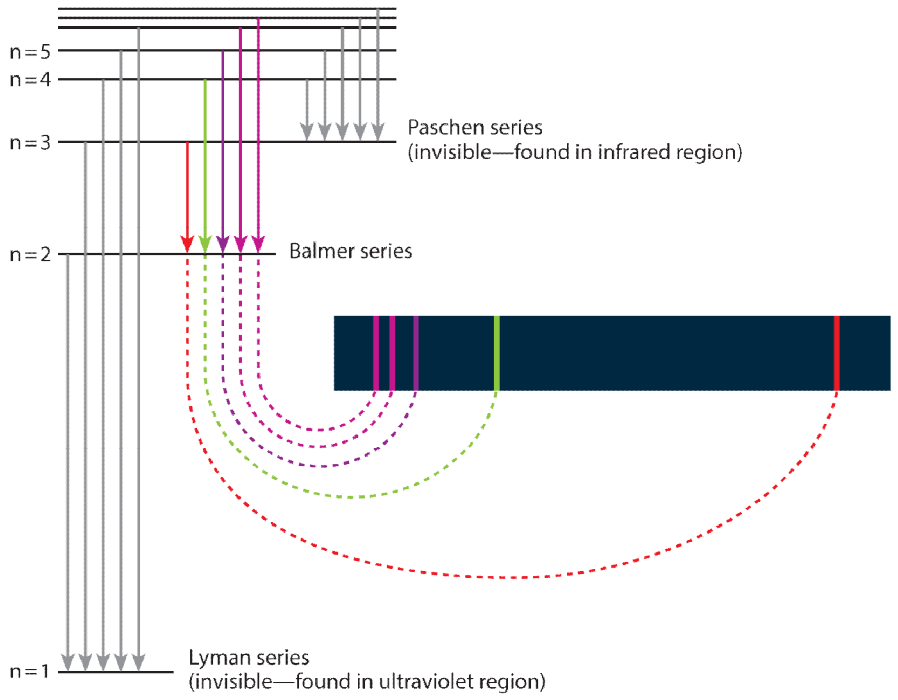
What sort of questions turn up on the Leaving Certificate Chemistry exam paper on this topic?

The Bohr Theory is frequently examined on the Leaving Certificate examination paper. The main questions require you to:

- Distinguish between ground state and excited state.
- Explain how emission line spectra occur.
- Discuss the evidence that emission spectra provide for the existence of energy levels in atoms.
- Explain why each element has a unique emission line spectrum.
- State the limitations of the Bohr Theory.

What tips would you give me when answering these questions?

- Study the diagram showing how the emission spectrum of hydrogen is formed. Note how each electron transition results in a line of particular wavelength (frequency) being formed. It is always a good idea to include a simple diagram like that shown as many marks can be obtained from a well labelled diagram.



- When linking the Bohr Theory to emission line spectra, always write out your explanation in the form of bullet points as shown above. This will help to ensure that you cover all the key points.