

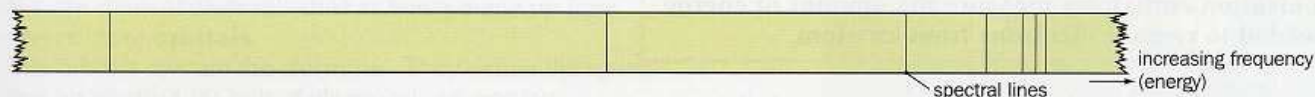
## Energy levels

*Extract from "Advanced chemistry for you", Lawrie RYAN, Nelson Thornes*

### Evidence for shells and sub-shells

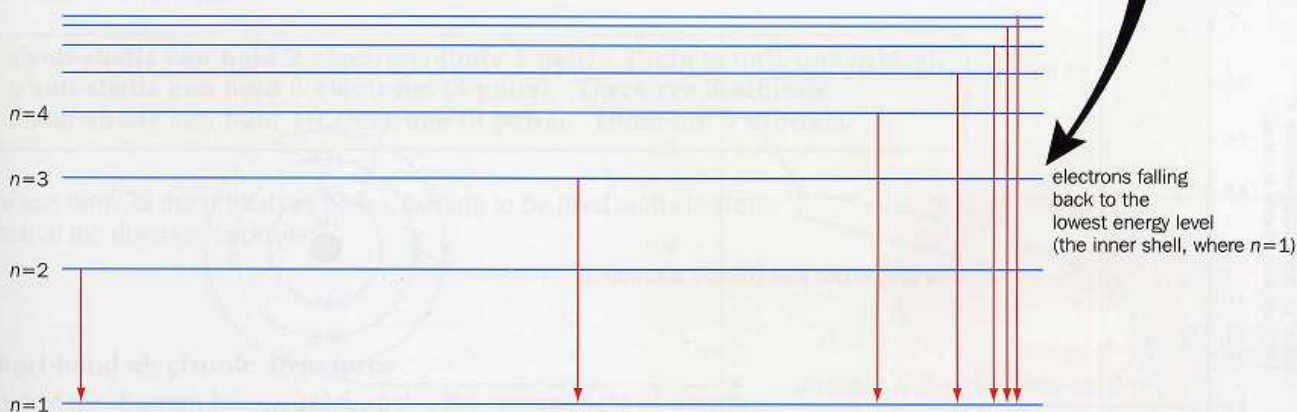
As you know from the last page, atomic spectra give us evidence that electrons occupy energy levels (or shells). Look at one of the series of lines you get from atoms of hydrogen:

*There was a young man called Bohr  
Who excited electrons galore!  
He spotted the signs  
From his spectral lines  
Of shells spreading out from the core!*

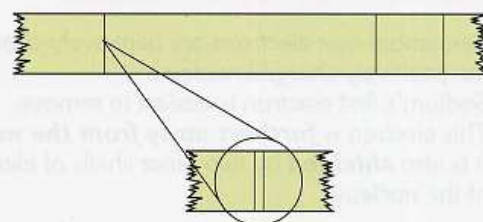


Each line shows the energy given out when an excited electron falls from a higher to a lower energy level. This series is called the **Lyman Series**. The spectral lines correspond to the energy given out when electrons return to the first shell. The diagram below shows how the spectrum relates to the energy levels:

Can you see how the lines in the spectrum are formed?



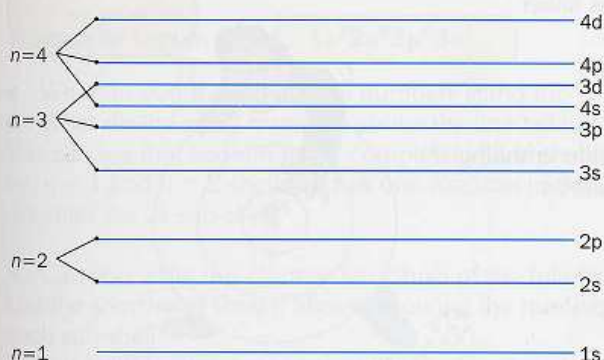
If you use more sensitive apparatus to look at atomic spectra, you can see some interesting details. What may appear to be single lines are in fact two or more lines that are very close together. So how can we explain these lines?



*A double line shown by 'high resolution spectroscopy'. There must be two energy levels (sub-shells) very close together to explain these lines*

Look at the diagram opposite: The energy levels (above  $n = 1$ ) seem to be made up from two or more shells. Their energy levels are very similar. We call these **sub-shells**.

The diagram below shows you how the sub-shells are arranged:



The sub-shells are labelled by letters s, p and d (there are also f sub shells in large atoms)

\*Notice how the sub-shells from the 3rd and 4th energy levels overlap.