

The Quantum Model

- each of the Bohr energy levels, n , is subdivided into subshells of different energy
- there are n^2 possible subshells for each value of n
- each subshell has a wave pattern associated with it (i.e. "shape")
- each time n is increased by one, a new type of subshell is introduced

ex. For $n = 1$, # of types of subshells = $n = 1$

$$\begin{array}{l} \text{subshell "shape"} \\ \# \text{ of subshells} = n^2 = 1^2 = 1 \implies 1s \text{ subshell} \quad \left. \vphantom{\# \text{ of subshells}} \right\} \text{ holds 2 e's} \\ \text{Bohr energy level} \end{array}$$

ex. for $n = 2$, # of types of subshells = $n = 2$

$$\begin{array}{l} \# \text{ of subshells} = n^2 = 2^2 = 4 \implies \begin{array}{l} 2s \\ 2p_x, 2p_y, 2p_z \end{array} \quad \left. \vphantom{\# \text{ of subshells}} \right\} \text{ holds 8 e's} \end{array}$$

- a new shape, "p" is introduced
- there are three of the "p" type subshells

ex. for $n = 3$, # of types of subshells = $n = 3$

$$\begin{array}{l} \# \text{ of subshells} = n^2 = 3^2 = 9 \implies \begin{array}{l} 3s \\ 3p_x, 3p_y, 3p_z \\ 3d, 3d, 3d, 3d, 3d \end{array} \quad \left. \vphantom{\# \text{ of subshells}} \right\} \text{ holds 18 e's} \end{array}$$

- a new shape, "d" is introduced
- there are five of the "d" type subshells

ex. for $n = 4$, # of types of subshells = $n = 4$

$$\begin{array}{l} \# \text{ of subshells} = n^2 = 4^2 = 16 \implies \begin{array}{l} 4s \\ 4p_x, 4p_y, 4p_z \\ 4d, 4d, 4d, 4d, 4d \\ 4f, 4f, 4f, 4f, 4f, 4f \end{array} \quad \left. \vphantom{\# \text{ of subshells}} \right\} \text{ holds 32 e's} \end{array}$$

- a new shape, "f" is introduced
- there are seven of the "f" type subshells

For atoms larger than the hydrogen atom, the subshells of each energy level are not equal (See figures 4.22 and 4.25 in your textbook). The three 2p orbitals are degenerate (ie. the same level of energy); however, the 2s orbital is of lower energy than the 2p orbitals. Also, the energy levels begin to overlap as the **principal quantum number (n)** increases. For example, the fourth energy level begins to fill before the third level is complete (ie. the 4s sublevel is of lower energy than the 3d sublevel).