Quantum Numbers

Click on the above link to read a story explaining Quantum numbers.

Pauli Exclusion Principle

Wolfgang Pauli

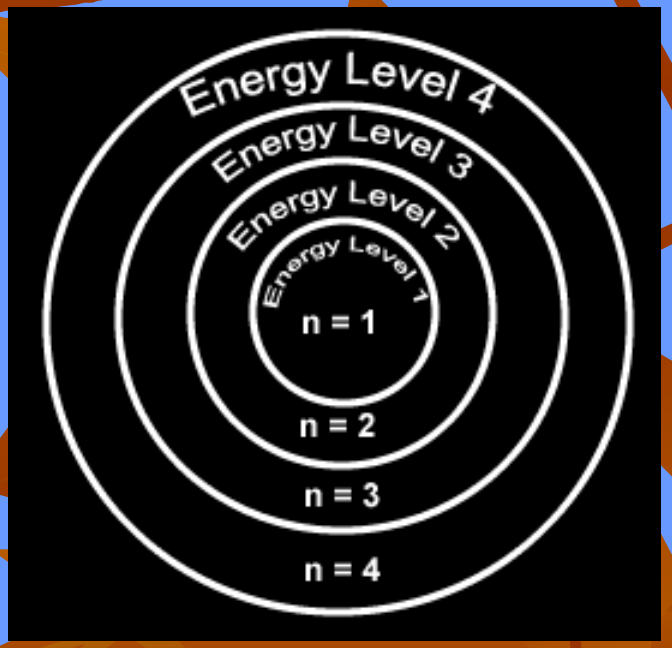
No two electrons in an atom can have the same four quantum numbers.

Principal Quantum Number

Generally symbolized by n, it denotes the shell (energy level) in which the electron is located.

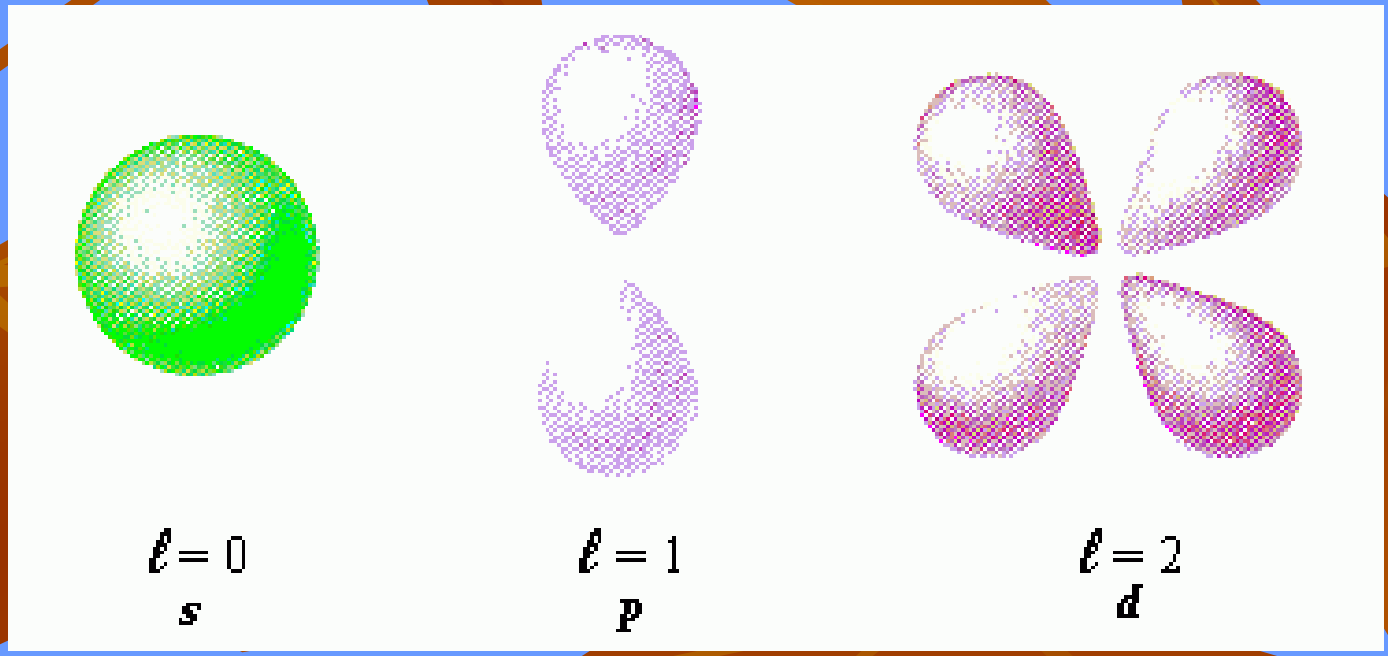
Number of electrons that can fit in a shell:

$2n^2$



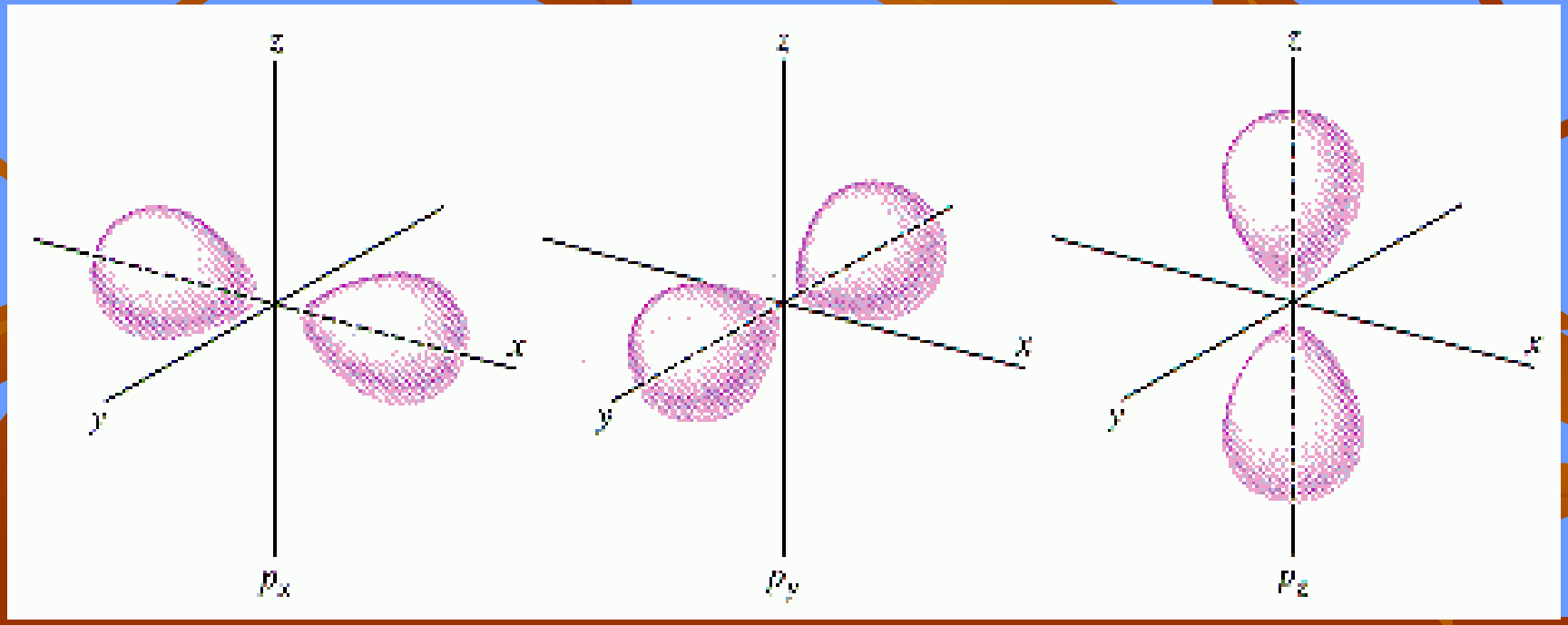
Angular Momentum Quantum Number

The angular momentum quantum number, generally symbolized by l, denotes the orbital (subshell) in which the electron is located



Magnetic Quantum Number

The magnetic quantum number, generally symbolized by *m*, denotes the orientation of the electron's orbital with respect to the three axes in space.



Assigning the Numbers

- The three quantum numbers (n, l, and m_l) are integers.
- The principal quantum number (n) cannot be zero.
- n must be 1, 2, 3, etc.
- The angular momentum quantum number (l) can be any integer between 0 and n - 1.
- For n = 3, l can be either 0, 1, or 2.
- The magnetic quantum number (m_l) can be any integer between -l and +l.
- For l = 2, m_l can be either -2, -1, 0, +1, +2.

Principle, angular momentum, and magnetic quantum numbers: n, l, and m_l

Table 7.2 Quantum numbers for the first four levels of orbitals in the hydrogen atom

n	l	Orbital designation	m_l	# of orbitals
1	0	1s	0	1
2	0	2s	0	1
	1	2p	-1, 0, 1	3
3	0	3s	0	1
	1	3p	-1, 0, 1	3
	2	3d	-2, -1, 0, 1, 2	5
4	0	4s	0	1
	1	4p	-1, 0, 1	3
	2	4d	-2, -1, 0, 1, 2	5
	3	4f	-3, -2, -1, 0, 1, 2, 3	7

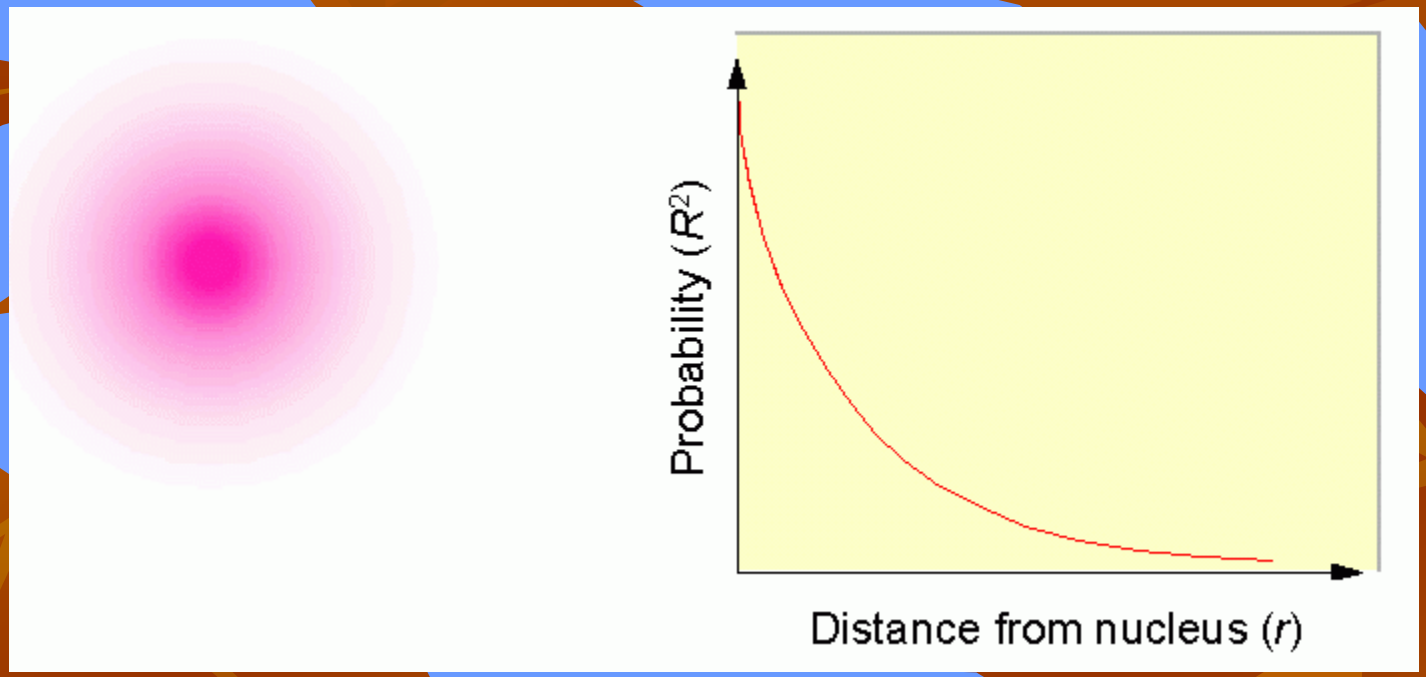
Spin Quantum Number (M_s)

Spin quantum number denotes the behavior (direction of spin) of an electron within a magnetic field.

Possibilities for electron spin:

$$+\frac{1}{2} \qquad -\frac{1}{2}$$

An orbital is a region within an atom where there is a probability of finding an electron. This is a probability diagram for the s orbital in the first energy level...



Orbital shapes are defined as the surface that contains 90% of the total electron probability.

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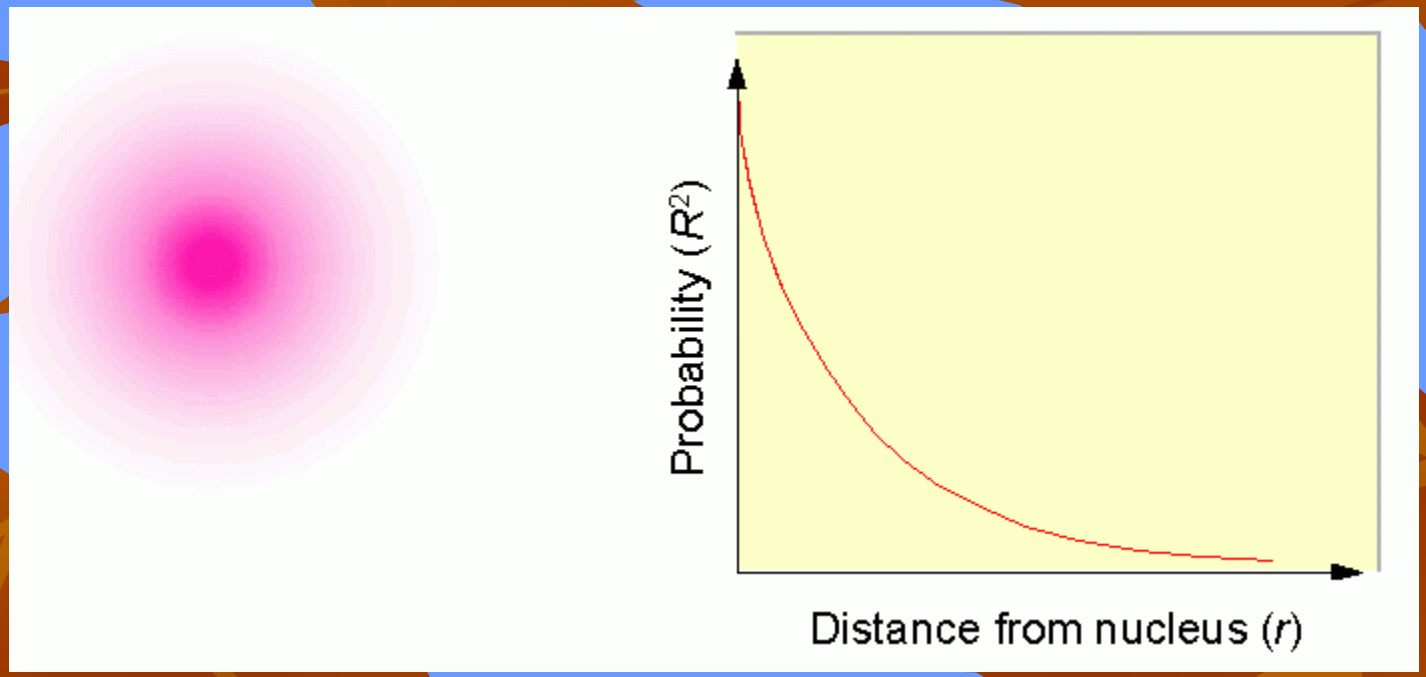


Orbital shapes are defined as the surface that contains 90% of the total electron probability.

Heisenberg Uncertainty Principle

Werner Heisenberg

"One cannot simultaneously determine both the position and momentum of an electron."

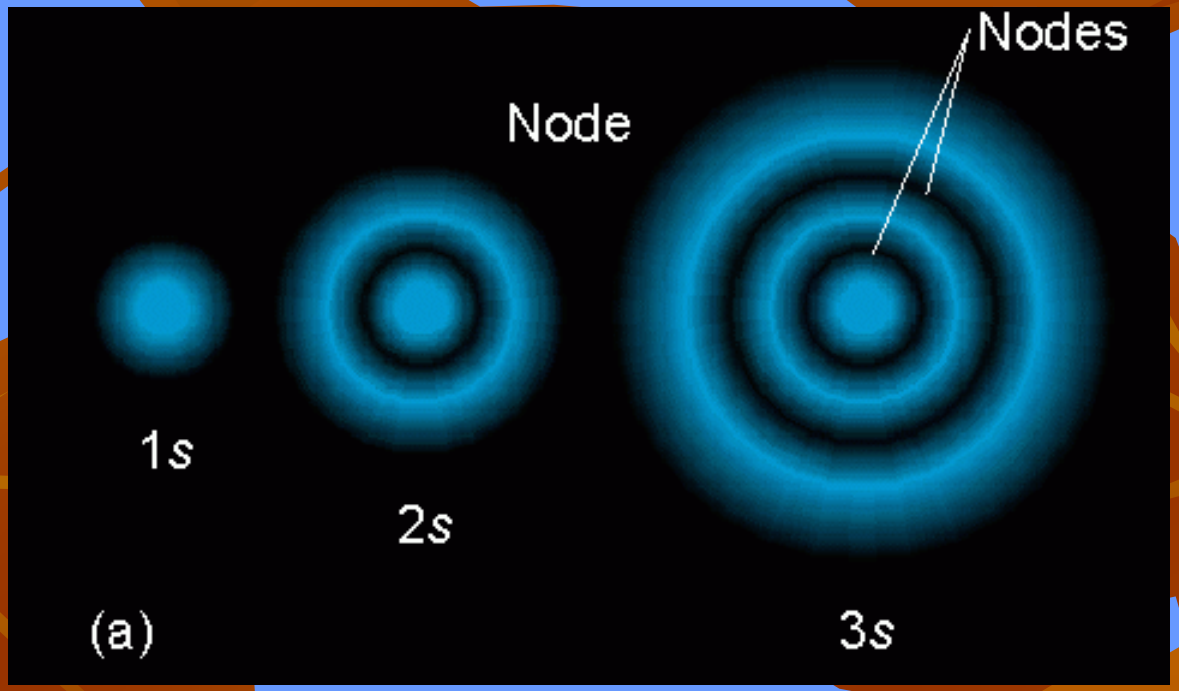
You can find out where the electron is, but not where it is going.

OR

You can find out where the electron is going, but not where it is!

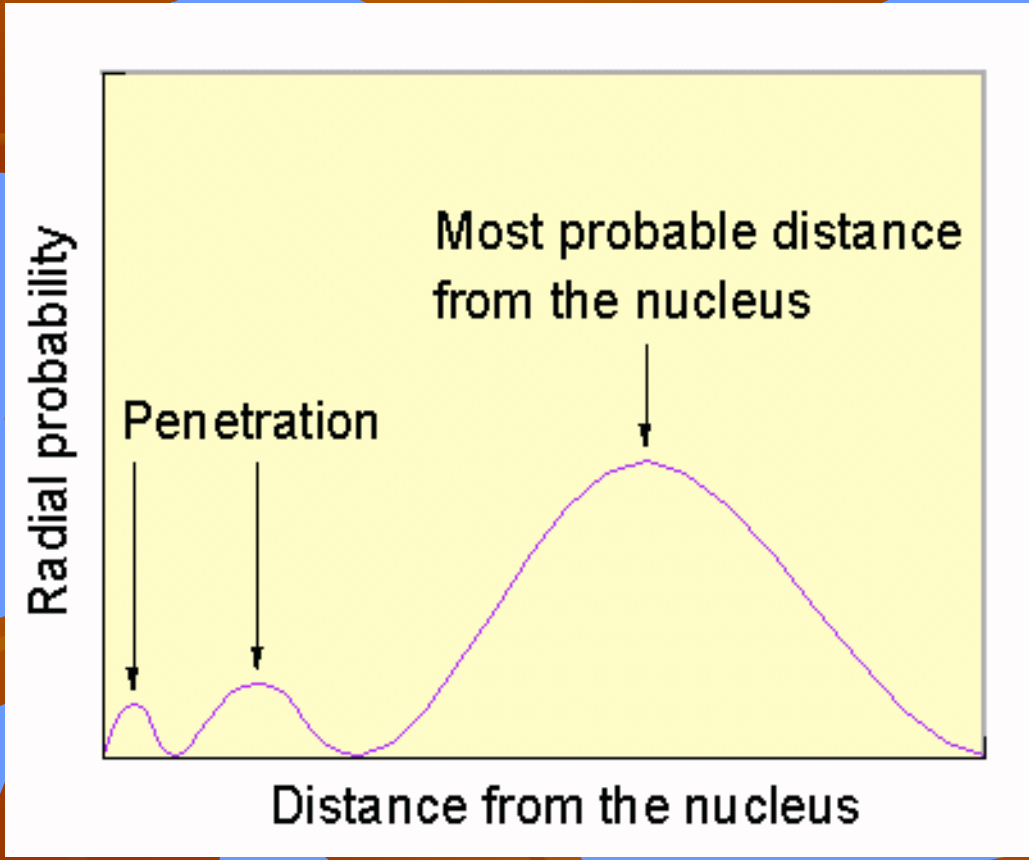
Sizes of *s* orbitals

Orbitals of the same shape (s, for instance) grow larger as n increases…



Nodes are regions of low probability within an orbital.

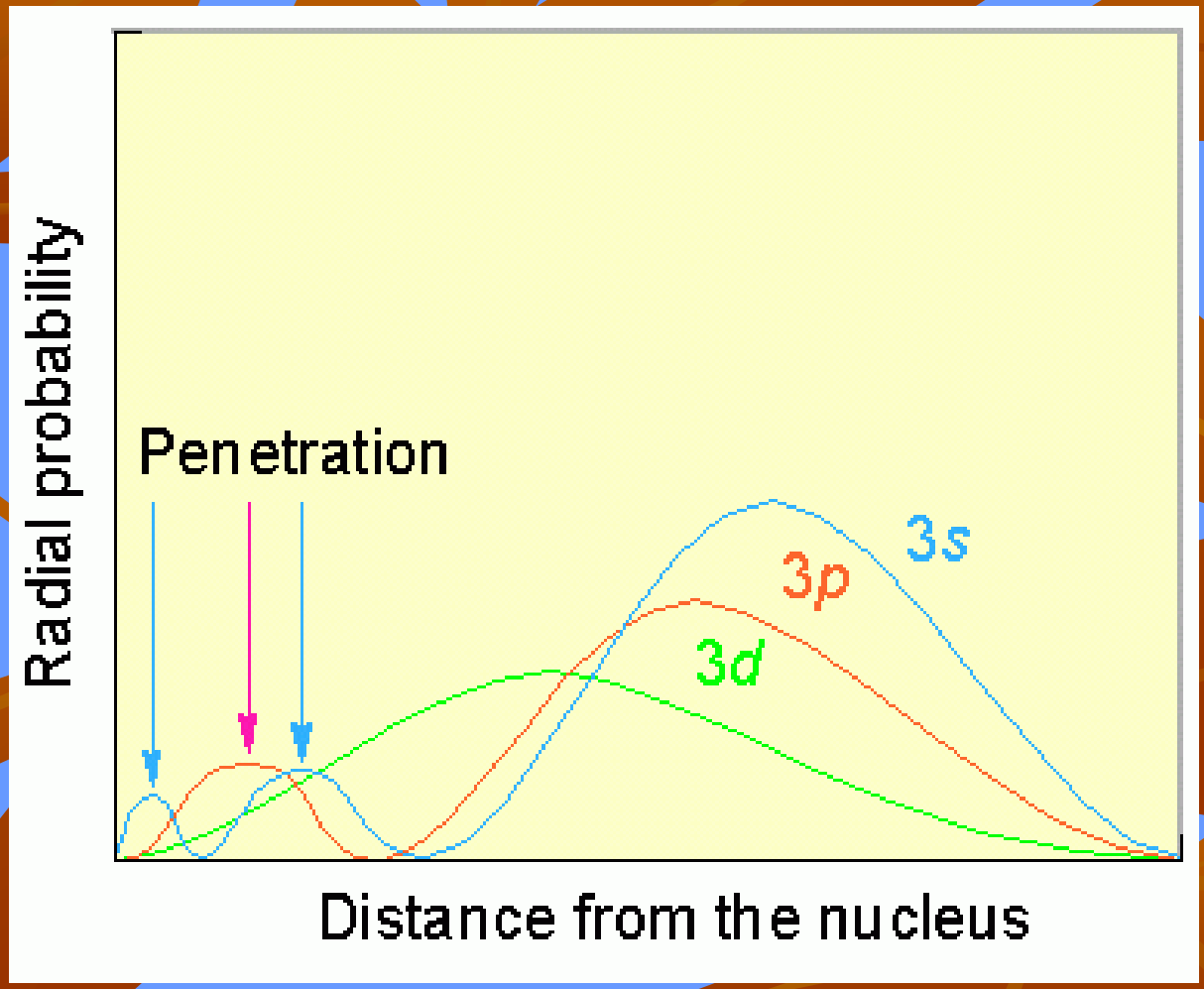
Orbitals in outer energy levels DO penetrate into lower energy levels. Penetration #1



This is a probability Distribution for a 3s orbital.

What parts of the diagram correspond to "nodes" – regions of zero probability?

Which of the orbital types in the 3rd energy level Does not seem to have a "node"?



WHY NOT?