

QUANTUM NUMBERS

QUANTUM THEORY

Designed to explain the electronic structure of atoms
The study of the wave nature of objects on an atomic scale

(Classical Physics – Newton’s Laws of Motion)
 (Works well if the object is big and slow)
 (Not so well if it is small and fast)

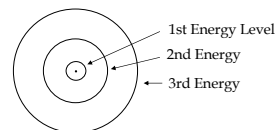
QUANTUM MECHANICAL MODEL

- Treats electrons as both waves and particles (wave-particle duality)
- Location of electrons are described in terms of average regions of most probable location (called orbitals)
- “Electron cloud”
- Of most importance is the energy associated with the electrons (not position)
- Allowed energy states can be described by quantum numbers

QUANTUM NUMBERS

Principal Energy Level, n

- most important in describing the size of an atom
- farther from the nucleus - more energy/larger radius



QUANTUM NUMBERS

Azimuthal, L (sublevel)

- determines general shape

1st Energy level	s
2nd Energy level	s p
3rd Energy level	s p d
4th Energy level	s p d f

	type of sublevel	Shape	# parts (orbitals)
L=0	s	spherical	1
L=1	p	dumb-bell	3
L=2	d		5
L=3	f		7

QUANTUM NUMBERS

Magnetic, m_l (distribution or orientation)

- indicates how electron cloud is directed
- m_l values from $-L$ to L

$$L = 0 \quad m_l = 0$$

$$L = 1 \quad m_l = -1, 0, 1$$

$$L = 2 \quad m_l = -2, -1, 0, 1, 2$$

QUANTUM NUMBERS**Electron Spin, m_s**

- each orbital may only have two electrons maximum
- electrons sharing an orbital have opposite spins
- values $+1/2, -1/2$ (clockwise/counterclockwise)

Quantum Numbers:

Describe possible energy states for electrons in an atom

Which energy states in an atom are occupied?

**AUFBAU PRINCIPLE**

Electrons will occupy the lowest energy state possible

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s

Diagonal Rule (a way to remember the order)

1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f ...

**PAULI EXCLUSION PRINCIPLE**

An orbital contains a maximum of two electrons (with opposite spins)

**ELECTRON CONFIGURATION**

Shows the distribution of electrons in energy levels and sublevels

Ex: H

He

Li

Be

Cl

So ... How are the electrons distributed within the sublevels?

**HUND'S RULE**

When electrons occupy orbitals of equal energy (called degenerate orbitals), each orbital gets one electron before any gets two

**ORBITAL DIAGRAM (BOX DIAGRAM)**

Shows the distribution of electrons within the orbitals

Ex: C

N

Co

