Announcements – 10/30/00

- **Problem Set Solutions**
  - **Ch. 4 & 5 now online** (also available in P/C Library)
  - **Ch. 6 & 7 coming later this week**
- **Website updates**
  - **Maxwell-Boltzmann moved** ("Goodies" page!)
- **Quiz**
- **Demo Explained**

1

Ammonia Fountain Demo

- The reaction:

$$\underset{\text{-46.11 kJ/mol}}{NH_3(g)} \rightarrow \underset{\text{-80.20 kJ/mol}}{NH_3(aq)}$$

ΔH = (-80.20 kJ/mol) - (-46.11 kJ/mol) = ***-34.18 KJ***

n = PV/RT = (1.0 atm)(2.0 L)/(0.08206)(298.15 K) = ***8.17 x 10^{-2} mol***

PV work = ΔnRT = ***200 J***

2

More QN and Orbitals

3. **The Magnetic Quantum Number (m_l)**
   -can have integer values from *l* ® *-l*
   -describes the orientation of the orbital in space

So, some examples:

n=1: only one value of *l* possible (0) **1s orbital**
only one value of m_l possible (0)

n=2: *l = 0, 1* (s and p orbitals)
For **l = 1** m_l -1 (**$_x$, 2p , 2p$_z$**)

n=3: *l = 0, 1, 2* (s, p and d orbitals)
l = 2: m =2, 1, 0, - -2 ( )

3

Orbital Energies

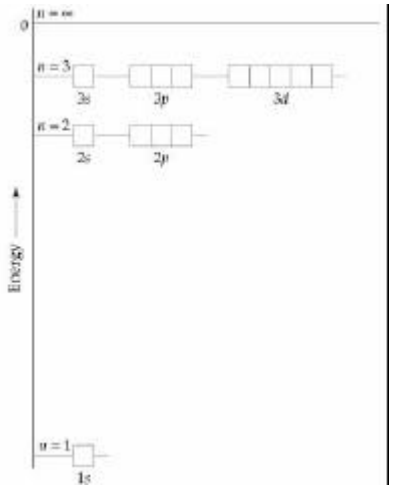
For Hydrogen:

-energies vary with ***n***

-same result as with Bohr

$$E_n = \frac{-(e^4 m_e)Z^2}{(8\varepsilon_0 h^2)n^2} = \frac{-R_H Z^2}{n^2}$$

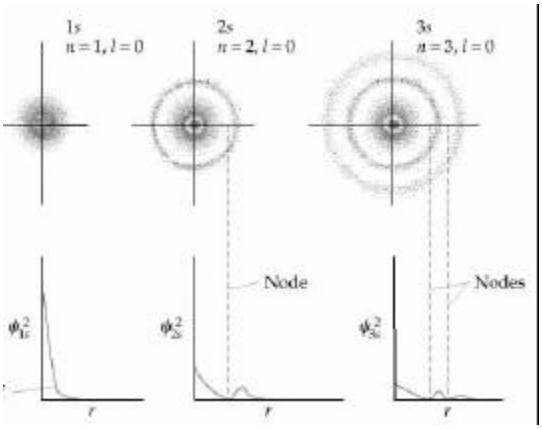
-also applies to other *one-electron* systems



4

Orbital Shapes: s-orbitals

- All s-orbitals are *spherical* but have different *radial* probability distributions:



•S-orbitals have *n-1* radial nodes

•As n increases, so does the orbital size

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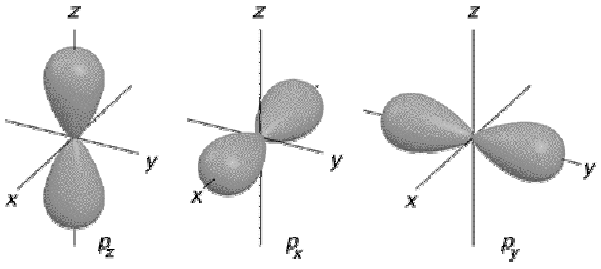
Orbital Shapes: p-orbitals



- p-orbitals are "dumbell" shaped
- Subscripts indicate primary orientation axis
- Nodal plane at nucleus
- As n increases, the size of the p-orbitals increases

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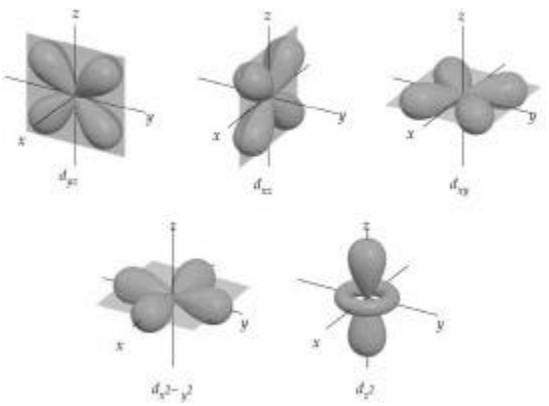
Orbital Shapes: d-orbitals

- Three "4-leaf clover" shapes in three planes (xy, xz, yz) oriented *between* the axes
- One "4-leaf clover" shape in xy plane oriented *along* the axes
- One dumbell shape with a doughnut in xy plane



I'm not making this up . . . really!

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Beyond Hydrogen

- For atoms with more than one electron, we use the same orbitals (phew!) BUT their energies are not the same.
- Electron energies can be related to the *effective nuclear charge* (Z_{eff}) they experience in an orbital:

$$\mathbf{Z_{eff} = Z - S}$$

-electrons in inner shells can *shield* the outer shell electrons from the full positive charge (***Z***) of the nucleus (***S = # of inner shell electrons***)

- In general: for a fixed value of ***n***, energies *increase* with increasing values of ***l***. (i.e., d > p > s)

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