11/6/2019

Heisenberg Uncertainty Principle

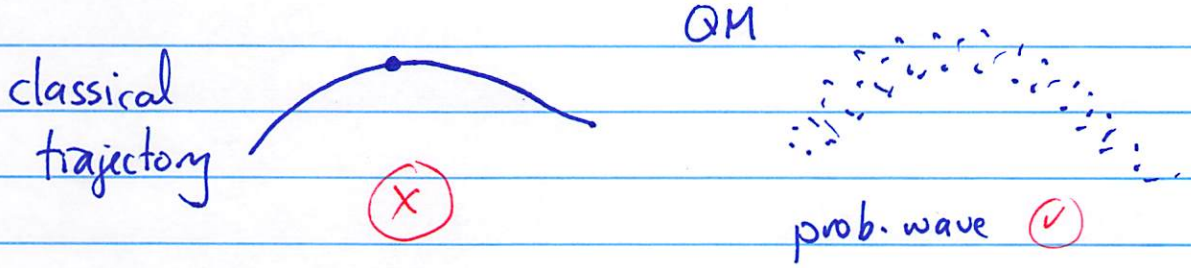
$$\Delta x \times m \cdot \Delta v \geq \frac{h}{4\pi}$$

$h = 6.626 \times 10^{-34}\ J \cdot s$

Δx: uncertainty in position

Δv: uncertainty in speed

- can't know exactly where something is!
  - ⟷ how fast something is going!



de Broglie: $\lambda = h/m \cdot v$

matter: ∿∿∿

Schrödinger Equation

wave function

H-atom. e^-

$$-\frac{\hbar^2}{2m_e}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\psi - \frac{e^2}{4\pi\varepsilon_0 \cdot r}\psi = E\psi$$

Energy

psi → ψ: wave function

ORBITAL (chemistry)

Max Born: $\psi^2 \propto$ prob. of finding e^-

Math:

- 4 Quantum Numbers (QN) associated w/ ψ.

- determine E, shape, size, orientation of ψ

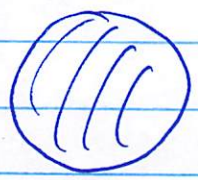
① Principal QN : n : 1, 2, 3, 4, ...

determines E, size of ψ

↳ $E_n = -\frac{R_H}{n^2}$ (H-atom)

ex: $n=1$  low E

$n=2$ 

$n=3$ 

higher E

② Angular momentum QN : ℓ

ℓ : 0, 1, ... , n-1

ex: n=5, ℓ = 0, 1, 2, 3, 4 } any one !

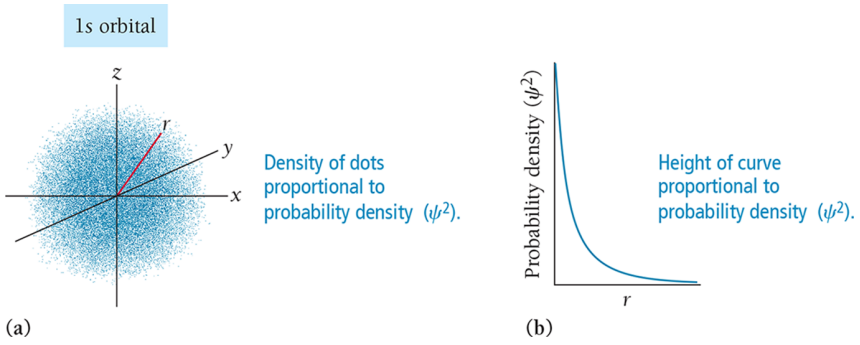
& slightly dets E for atoms w/ 2 or more e⁻s
1e⁻ ~ no affect on E. (H)

dets the shape of ψ

	ψ	letter
ex: $\ell=0$		s
$\ell=1$		p
$\ell=2$		d
$\ell=3$		f

Probability Density for *s* Orbitals ($l = 0$)

The probability density function represents the total probability of finding an electron at a particular point in space.



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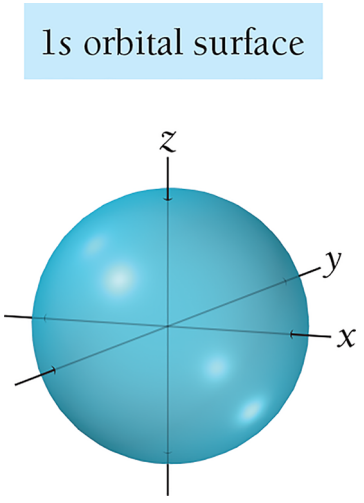
$l = 0$, the *s* Orbital

- Each principal energy level has one ***s*** orbital.
- Lowest energy orbital in a principal energy state
- Spherical
- Number of nodes = $(n - 1)$



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(3) Magnetic QN: m_ℓ

m_ℓ : $-\ell, \ldots, 0, \ldots, +\ell$

ex: $\ell = 2$, $m_\ell = -2, -1, 0, +1, +2$

- doesn't affect E (unless there's a magnetic field)
  dets orientation of ψ

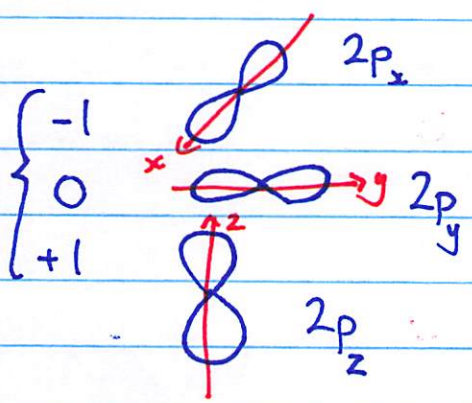
$n=1$, $\ell=0$, $m_\ell=0$  1s

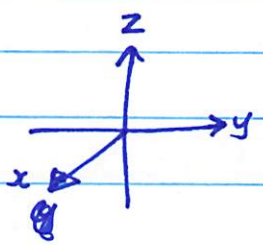
$n=1$, $\ell=0$

1s

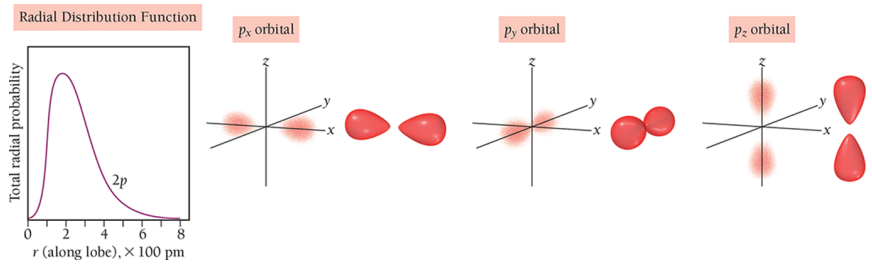
$n=2$, $\ell=1$, $m_\ell = -1, 0, +1$

2p





p Orbitals (*l* = 1)



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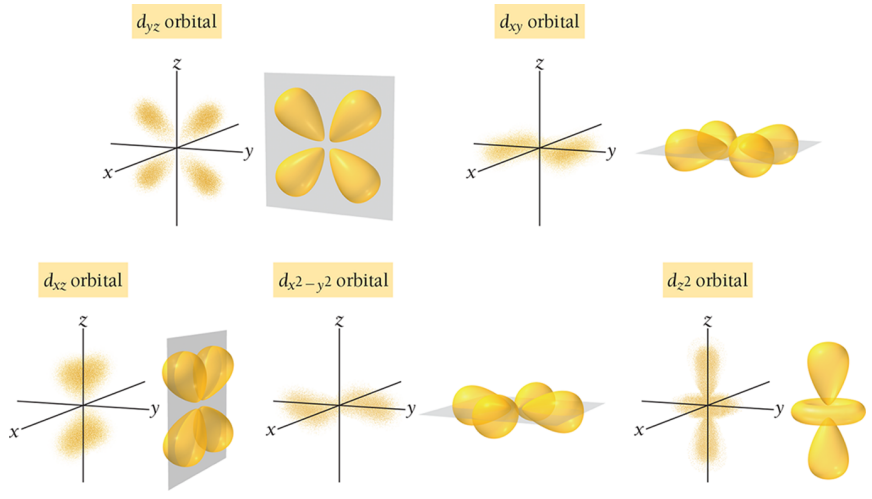
d Orbitals (*l* = 2)



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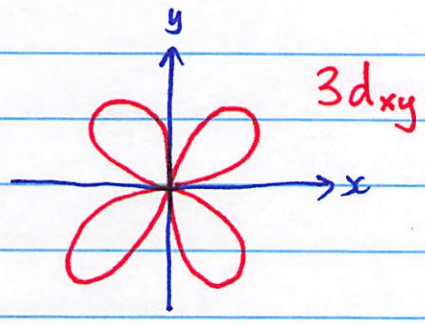
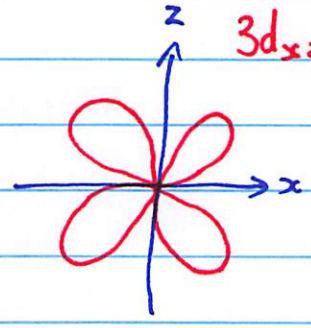
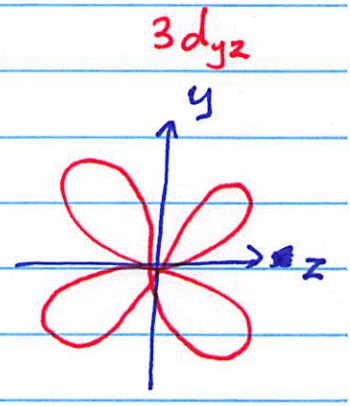
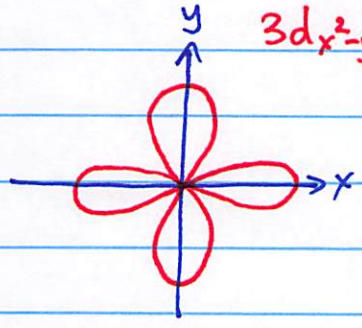
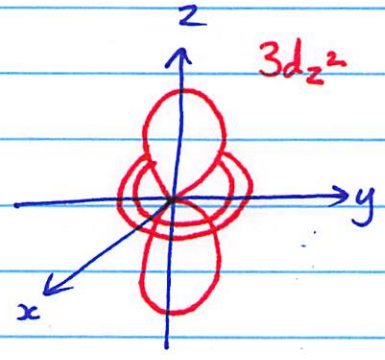
$n=3,\ \underbrace{l=2}_{3d},\ m_l = -2, -1, 0, +1, +2$



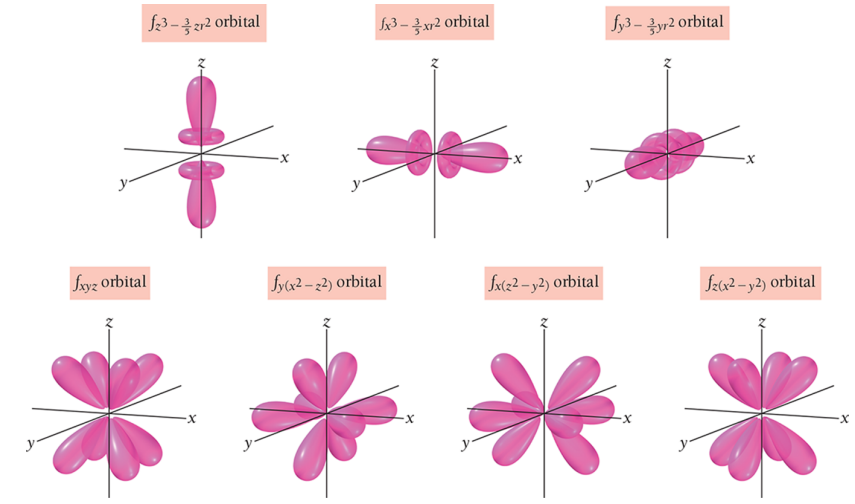








f Orbitals ($l = 3$)



Pearson

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