Don't need to write

Introduction to Electrons

The electron is a theory we use; it is so useful in understanding the way nature works that we can almost call it real.

- *Richard P. Feynman*

...will you understand what I'm going to tell you?...No, you're not gong to be able to understand it...I don't understand it. Nobody does.

- *Richard P. Feynman*

Don't need to write

The Bohr Model of the Atom

Neils Bohr

I pictured electrons orbiting the nucleus much like planets orbiting the sun.

But I was wrong! They're more like bees around a hive.

Don't need to write

Quantum Mechanical Model of the Atom

Mathematical laws can identify the regions outside of the nucleus where electrons are most likely to be found.

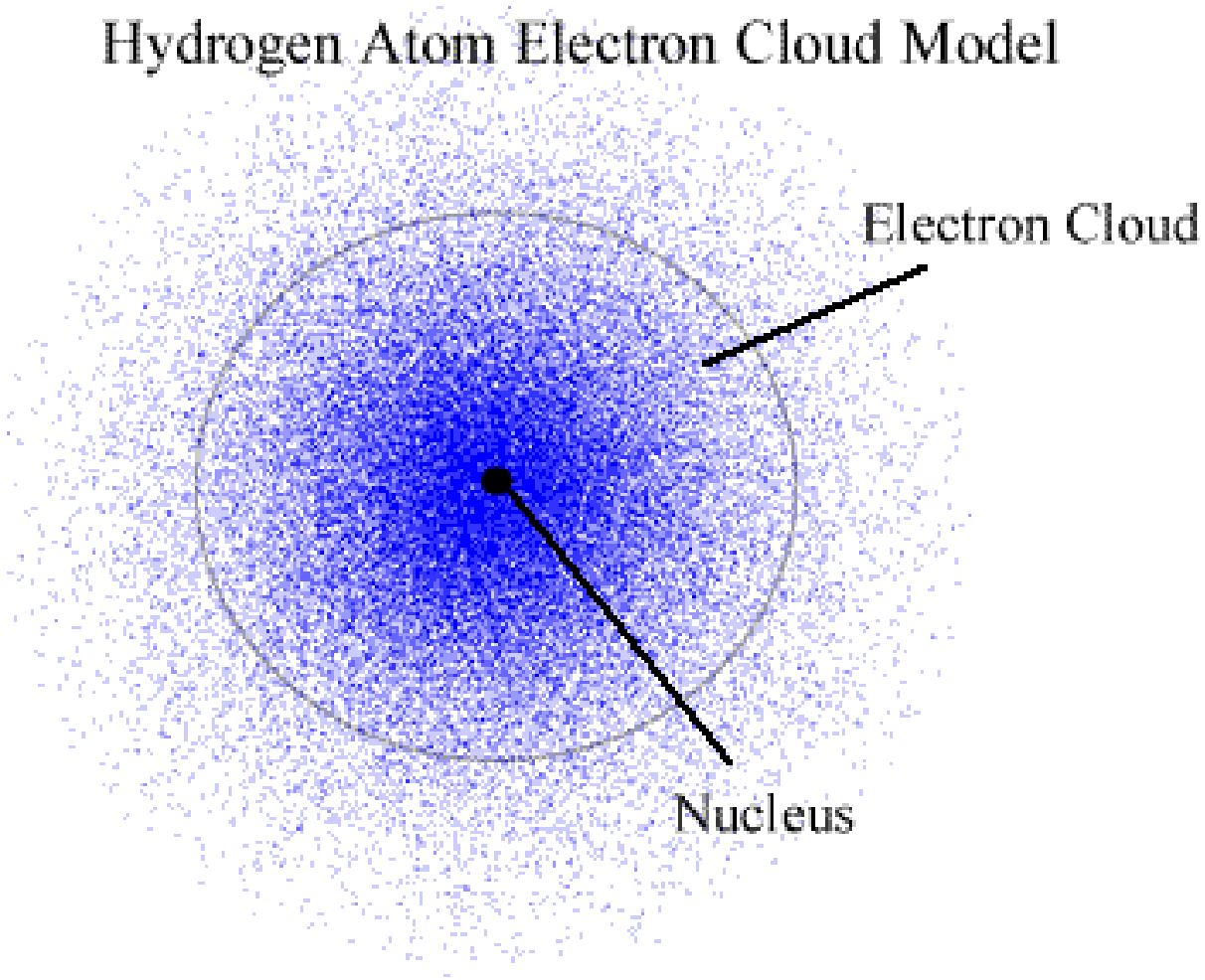
The math is beyond the scope of this class…

Atomic Orbitals

"An area where an electron is most likely to be found."

"A probability cloud"

- *A region where there is a high probability of finding an electron. A mathematical function…*
- *Orbital shapes are defined as the surface that contains 90% of the total electron probability.*


Hydrogen Atom Electron Cloud Model
Electron Cloud
Nucleus

How do we describe orbitals?

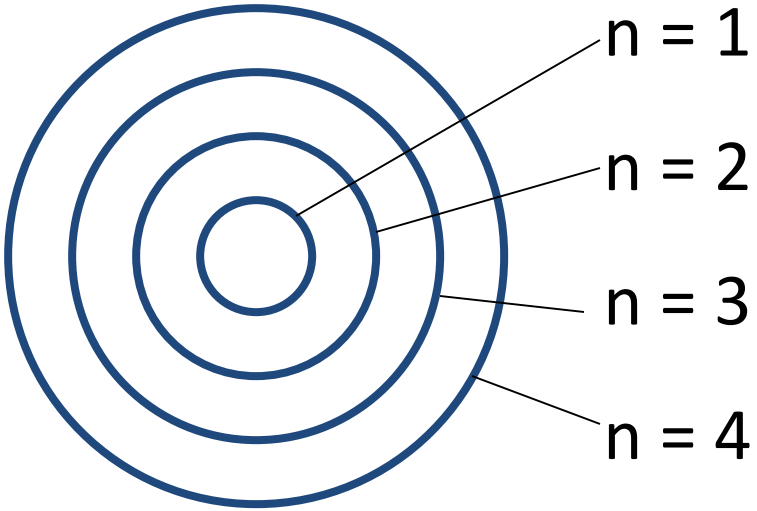
1) Energy level
2) Shape
3) Orientation
4) How many electrons are in each orbital

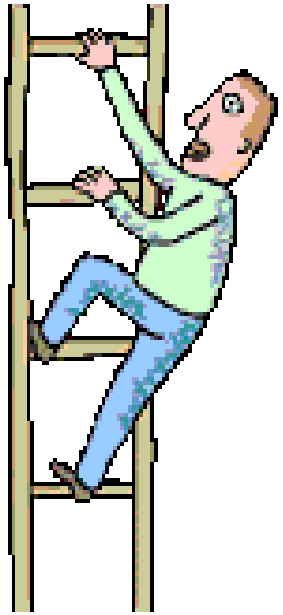
Energy Levels

Different orbitals are in different energy levels

n = 1, 2, 3, 4, 5, 6, 7.

1 = lowest energy, closest to the nucleus





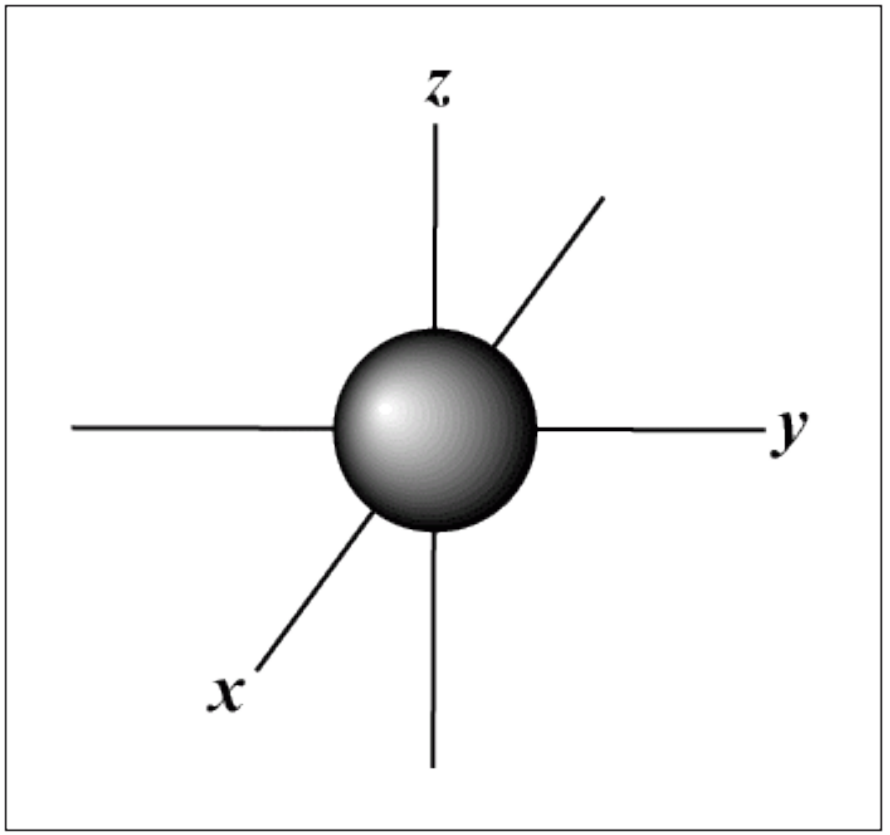
Orbital Shape

Different orbitals have different shapes

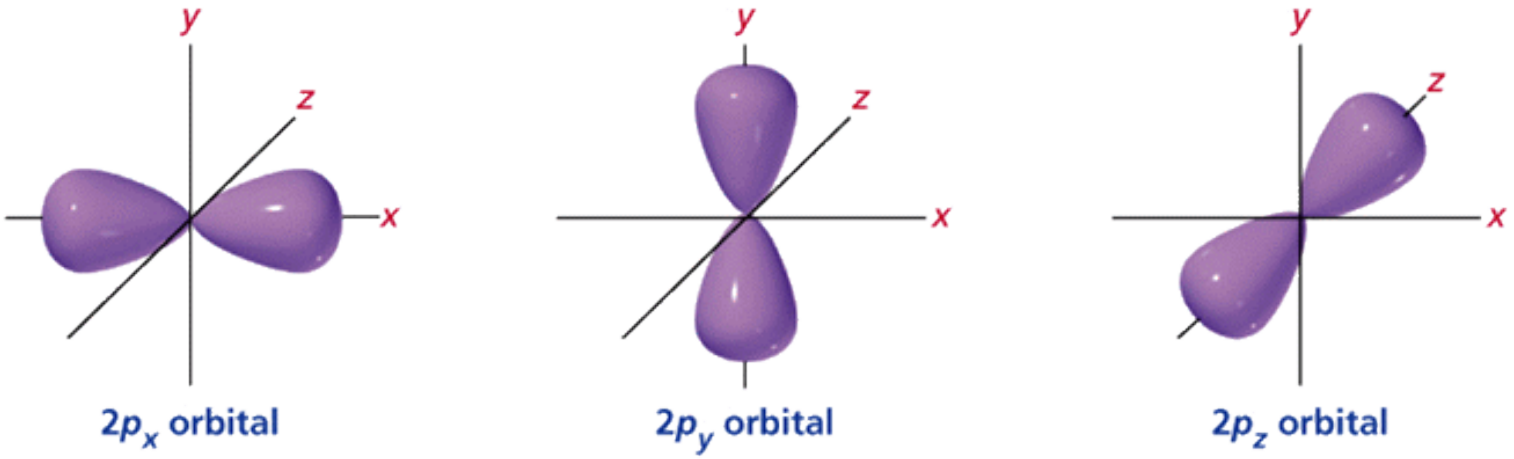
s, p, d, f

s Orbital shape

The ***s*** orbital has a spherical shape centered around the origin of the three axes in space.



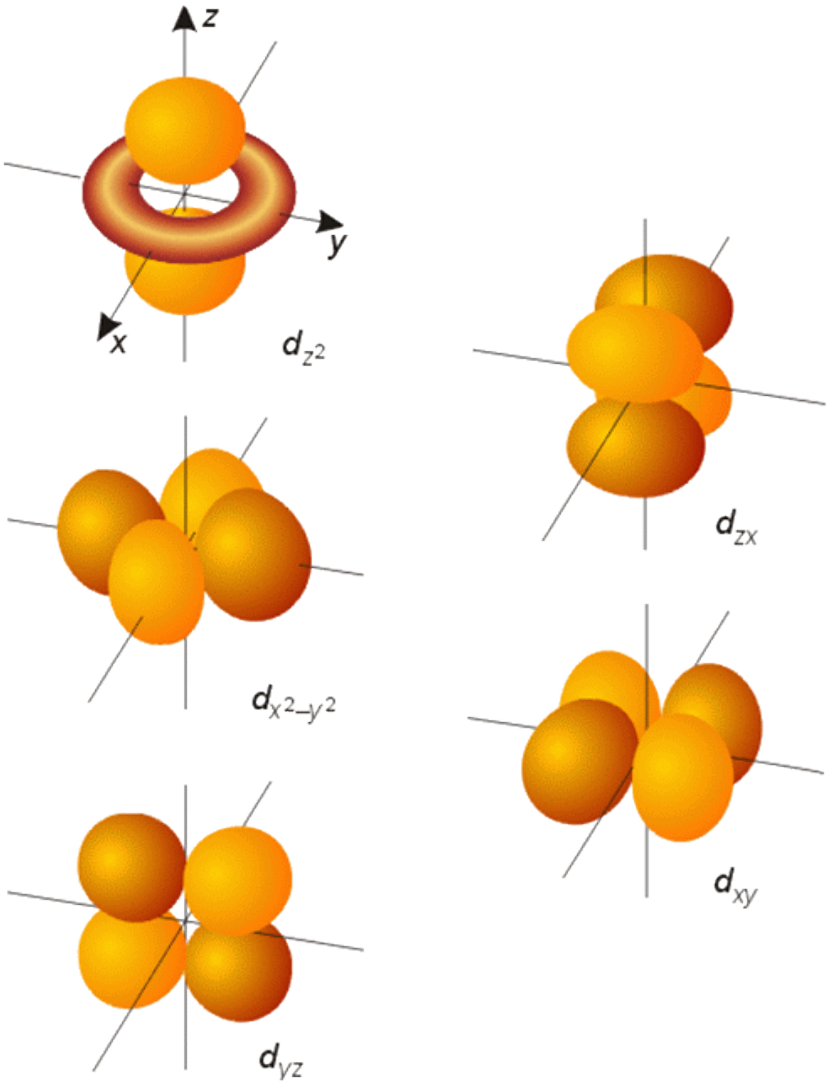
p orbital shape



There are three or double-lobed *p* orbitals in each energy level above n = 1, each assigned to its own axis (x, y and z) in space.

Petal shaped, dumbbell shaped, peanut shaped

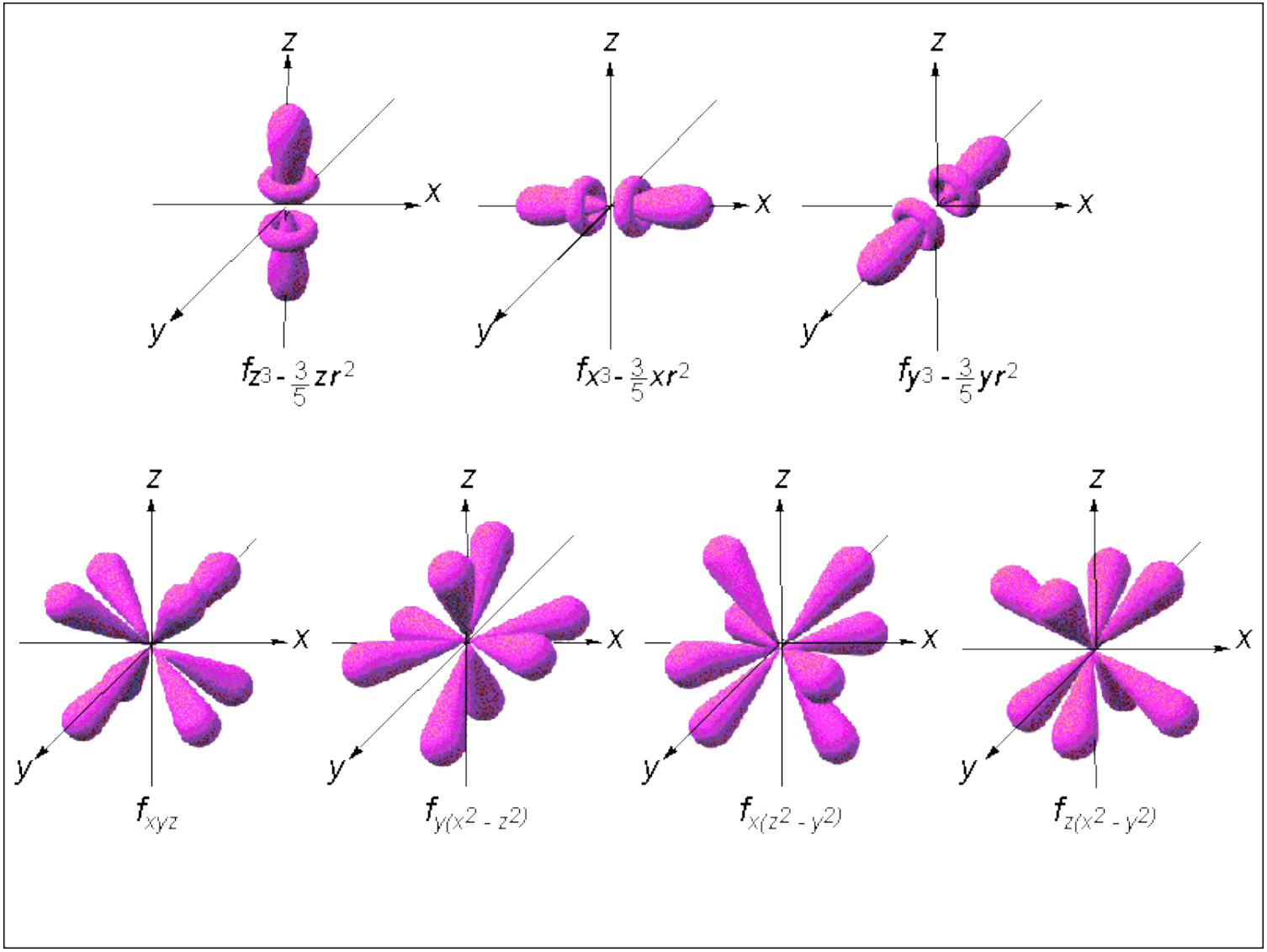
d orbital shapes



- d orbitals are weird!
- Five *d* orbitals that are found in the *d* sublevels beginning with n = 3.
- *"double dumbbells" or "dumbbell with a donut"!*

Shape of f orbitals

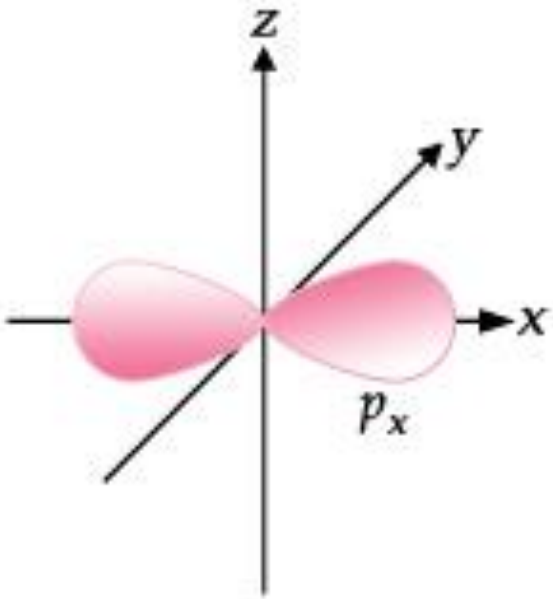
"funky" shaped!



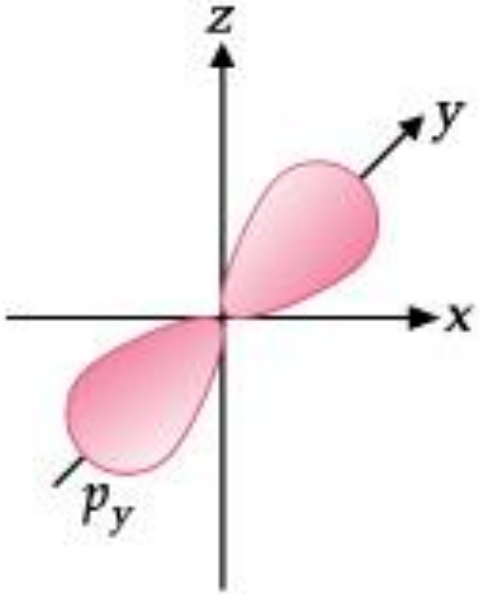
Orbital Orientation

Different orbitals have different orientations

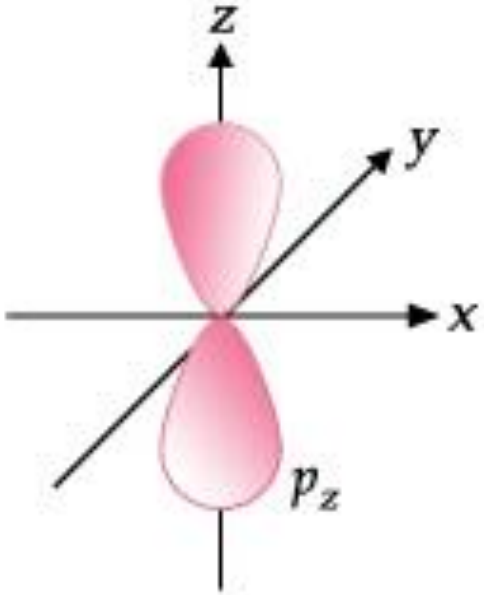
x, y, z (axis)



p_x orbital



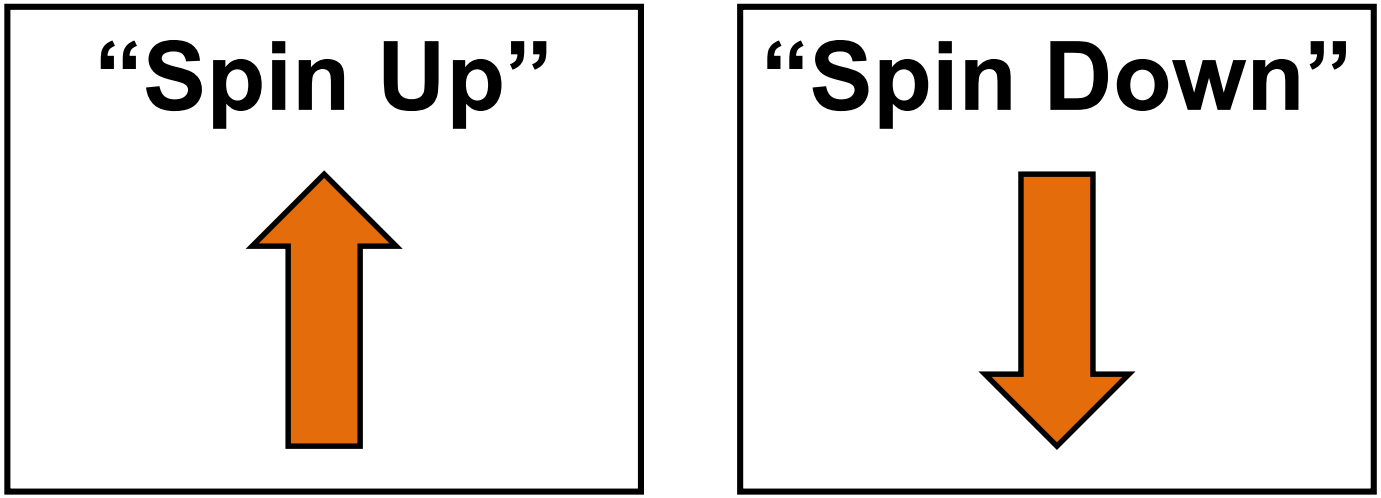
p_y orbital



p_z orbital

Electrons in an orbital

Each orbital is only allowed to have TWO e^-s



So how do I tell someone exactly where an electron is???

Think about where you live…

California	State
Pleasanton	City
Ferdinand Avenue	Street
#2345	House #

You can write an ADDRESS for where you live

So couldn't you write an ADDRESS for where the electrons are in an atom???

Where do e- live?
What is the address for one?

State	⇢	Energy Level
City	⇢	Type/Shape of Orbital
Street	⇢	Orientation
House #	⇢	Spin up or Spin down

Electron Configuration is an address!

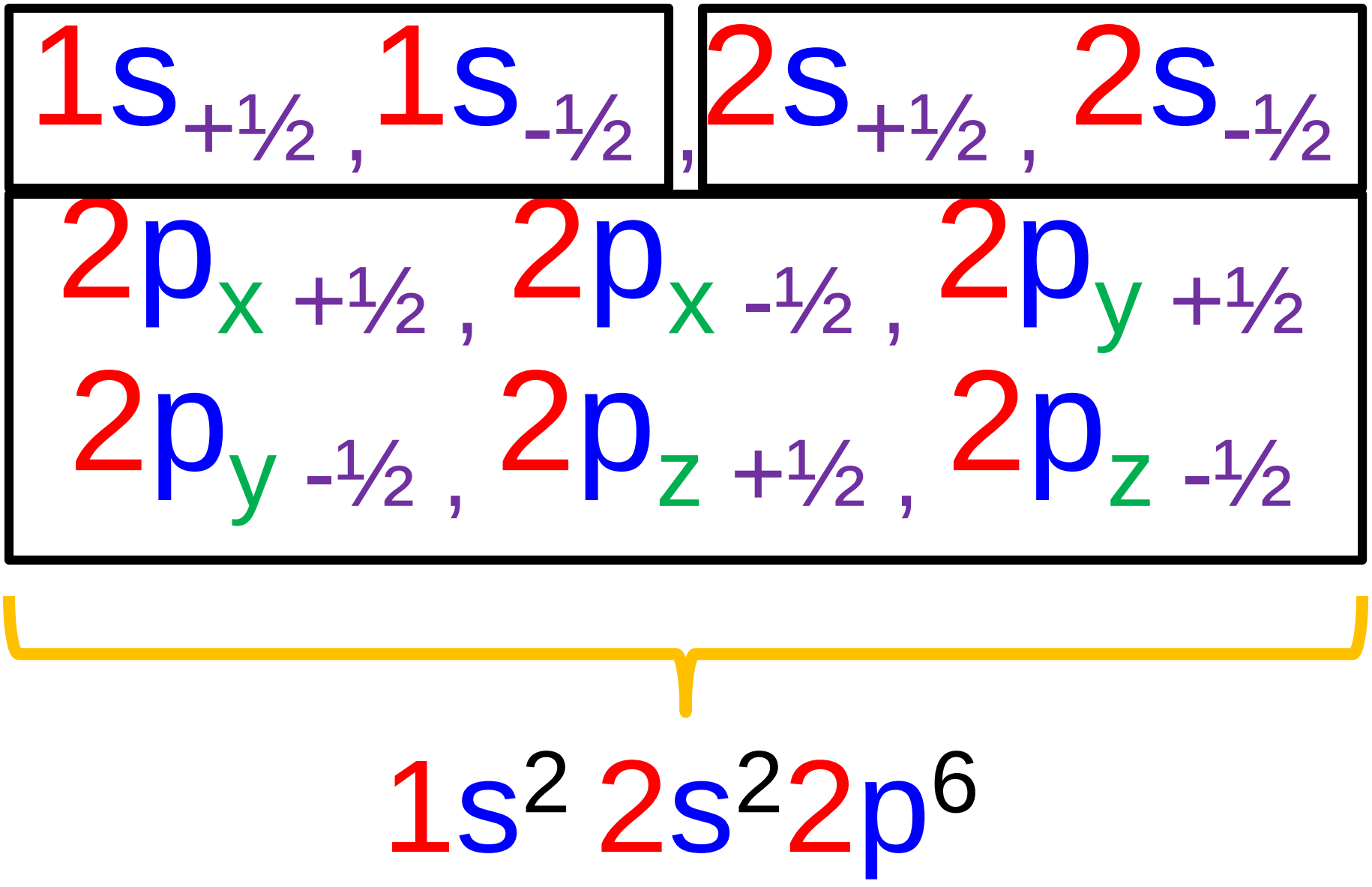
$$2p_x +½$$

Energy Level

Type/Shape of Orbital

Orientation

Spin up or Spin down **+ ½ , - ½**


1s+½ , 1s-½ , 2s+½ , 2s-½
2px +½ , 2px -½ , 2py +½
2py -½ , 2pz +½ , 2pz -½
1s2 2s2 2p6

Want to describe where ALL the e^-s in an atom were?

Shrink it down and only list the basics!

Energy levels

Shapes of Orbitals

Number of electrons in each orbital

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

$= 2+2+6+2+4 = 16\ e^-$ Sulfur!

Steps to finding all the electrons

1) Pick an **atom**

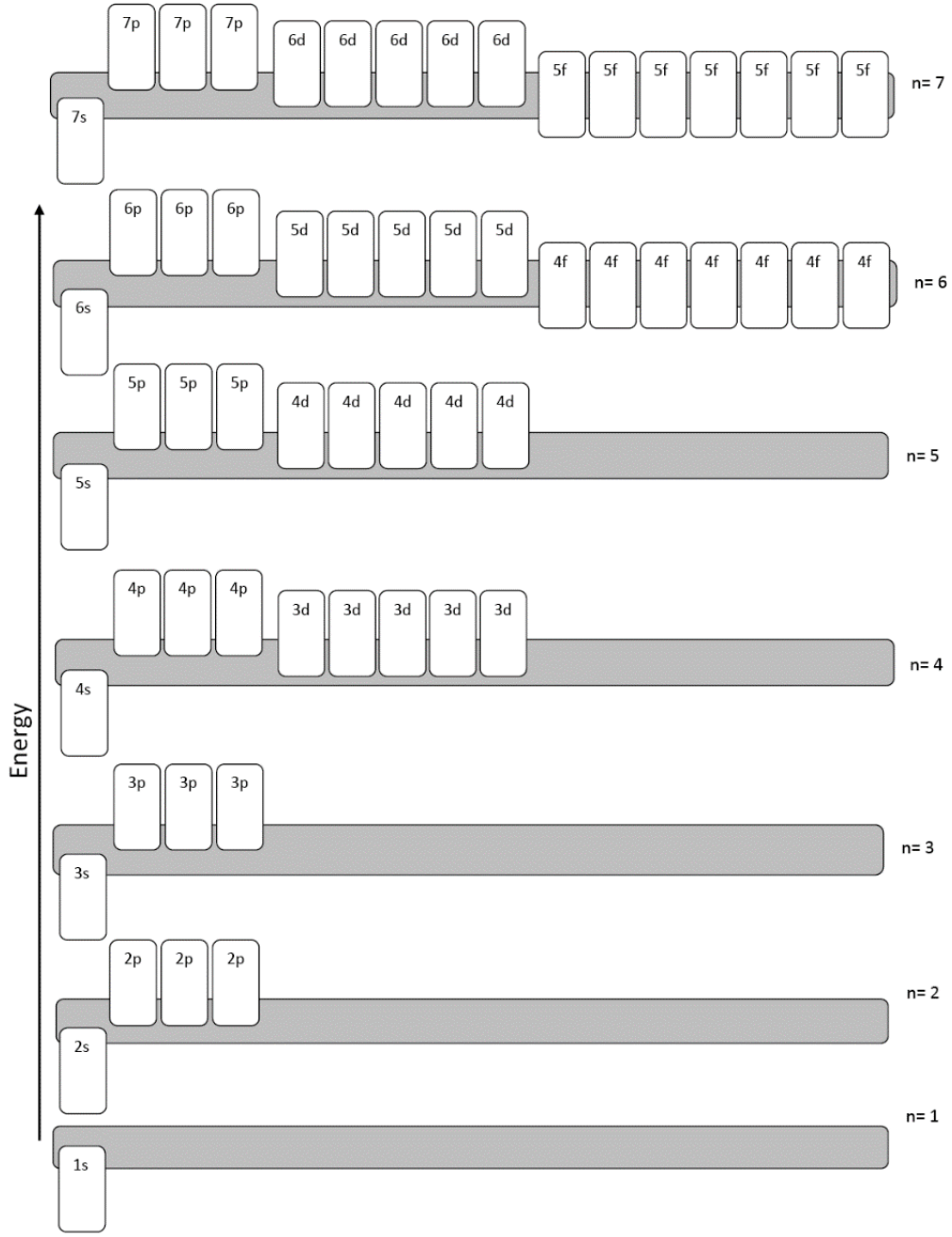
2) Find the number of **electrons it has**

3) Start putting electrons into the **orbitals**
Use an **ORBITAL CHART/DIAGRAM**

4) List which **orbitals** you used and **how many** electrons in each one

Orbital Diagram

A chart that shows you the order that the orbitals go in.



Rules for putting e⁻s in orbital diagrams

Aufbau Principle

An electron occupies the lowest energy orbital that it can.

Means: **Fill from the bottom up**

Electrons are lazy!

Rules for putting e⁻s in orbital diagrams

Pauli Exclusion Principle

No two electrons in the same atom can have the same set of 4 quantum numbers

Means: **If there are two e⁻s in one orbital, one must be spin up, one spin down.**

They can't have exactly the same "address"

Rules for putting e⁻s in orbital diagrams

Hund's Rule

Orbitals of equal energy are each occupied by one electron before any orbital is occupied by a second electron.

Means: **If there are more than one orbital at the same energy, put one electron into each orbital before pairing up**

Don't share a bedroom unless you have to!