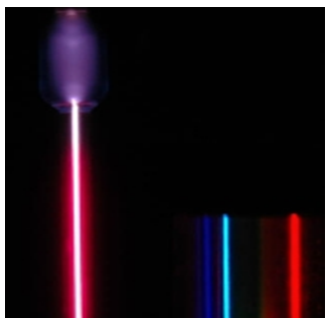


4.2 – Quantum Theory

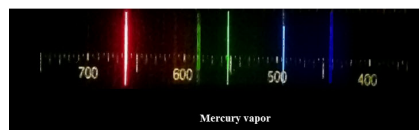


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Atomic Emission Spectra (AES)

Heated elements emit a spectrum allowing every element to be identified (like a fingerprint)

This is not a continuous spectrum, like white light, but banded at particular frequencies (Demo: Fluorescent Lights)



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Quantum Theory & the Atom

Niels Bohr (1913) proposed a model to explain AES:

Electrons reside only in specific levels (circular orbits) in an atom, like unevenly spaced rungs of a ladder.

They absorb (and emit) specific amounts of energy during moves between levels.

Electrons start at a ground state, and become excited from this level by absorbing energy.

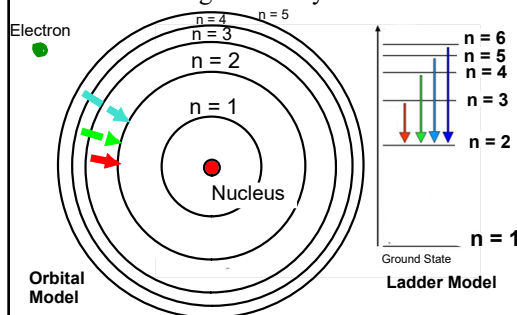


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Hydrogen Spectrum

Bohr assigned the different energy levels of hydrogen a “quantum number” (called n).

Electrons lose or gain as they move between levels.



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Limits to the Bohr Model

Bohr’s model only explained hydrogen, not any other element’s observed spectrum.

His model also doesn’t account for chemical behavior of atoms.

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Quantum Mechanical Model

Light has wave and particle-like behavior.

In 1924 Louis de Broglie wondered if particles could have wavelike behavior.

Yes, it turns out, and he derived an equation for it:

h = Planck’s Constant: 6.63×10^{-34} J·s,
 m = mass (kg),
 v = velocity (m/s)

$$\lambda = \frac{h}{mv}$$

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1. Review!

How many electrons does Scandium have?
21

How many electrons does Uranium have?
92

How many electrons in carbon-14?
6

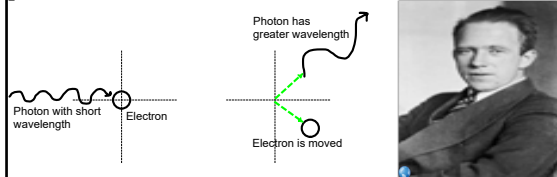
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Heisenberg Uncertainty Principle

How do you find a floating balloon in a dark room?

Werner Heisenberg showed that it is impossible to take any measurement of an object without disturbing it.

The upshot: you can't determine a path of an electron in orbit, only a probability that it will be at a certain point at a certain time.



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Wave Equation

In 1926 Erwin Schrödinger devised an equation that worked for all elements.

His model treats electrons as waves, assigning a probability that they will be found somewhere around a nucleus.

This model unlocked the different shapes of energy levels that electrons have.



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Electron Orbital Structure

Ground-state electrons occupy up to 7 energy levels (n numbers)

Ex: Really odd 7 story apartment building.

Energy levels have sublevels called s, p, d, f according to shape.

1st level has one, 2nd has two, etc.

Ex: apartments per floor.

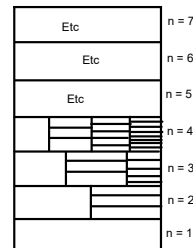
Sublevels have a number of orbitals:

$$s = 1 \quad p = 3 \quad d = 5 \quad f = 7$$

Ex: rooms per apartment

Each orbital holds two electrons.

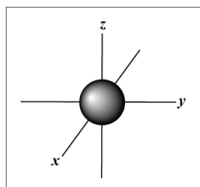
Ex: two people per room.



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S Sublevel = 1 Orbital

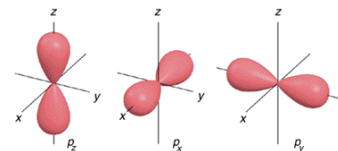
Spherical:



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P Sublevel = 3 Orbitals

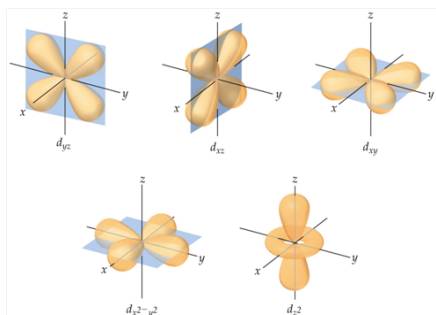
Dumbbell shaped:



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D Sublevel = 5 Orbitals

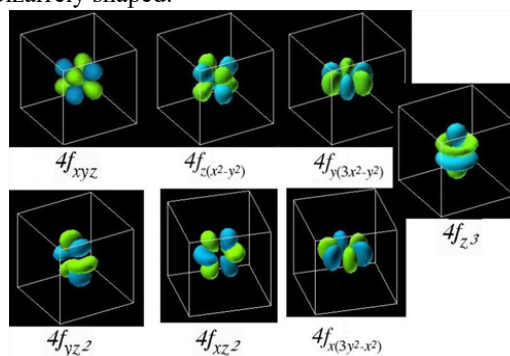
Double Dumbbell shaped:



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F Sublevel = 7 Orbitals

Bizarrely shaped:



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Summary:

Energy Levels - 7 Possible

Possible Sublevels:	s	p	d	f
Orbitals/sublevel:	1	3	5	7
2 electrons/orbital:	2 e ⁻	6 e ⁻	10 e ⁻	14 e ⁻

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Homework

Preview 4.3

4.2 Problems in your Booklet
Due: Next Class

Dress for Lab Tomorrow!!!

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