Announcements

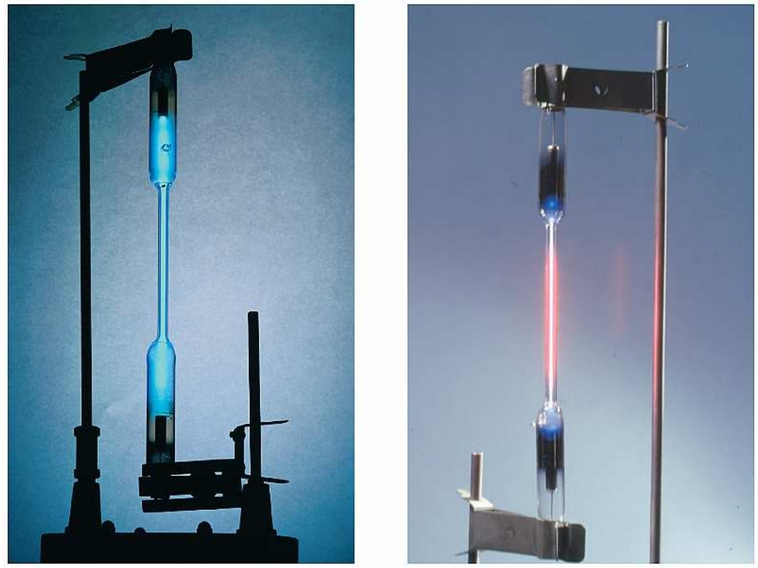
Monday, April 06, 2009

Exam 1 average ~72%. Key will be posted soon.

Discussion assignment 2 is now available. Reserve your topic before class next week (Monday, April 13).

Lecture 8 post and lecture 9 pre assignments due next Monday, April 13.

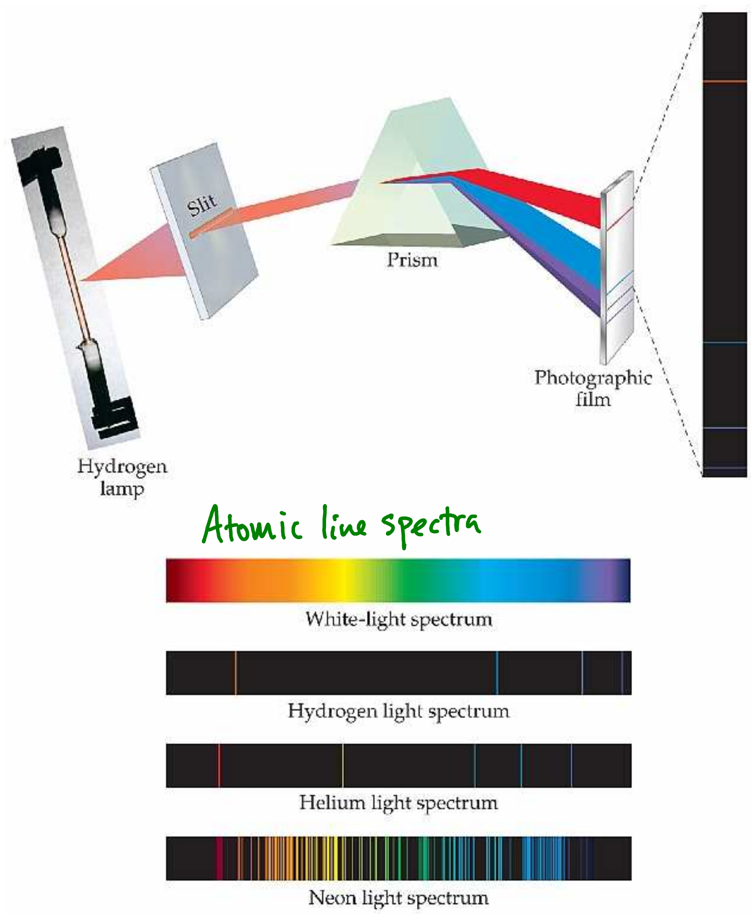
A **gas lamp** is a sealed glass tube that contains a gas sample, and **glows** when a high voltage is applied to it.



Hg(*g*) $H_2(g)$

But **only certain wavelengths** of light are given off by a gas lamp.

Compare with the continuous spectrum given off by a white light source like a light bulb.

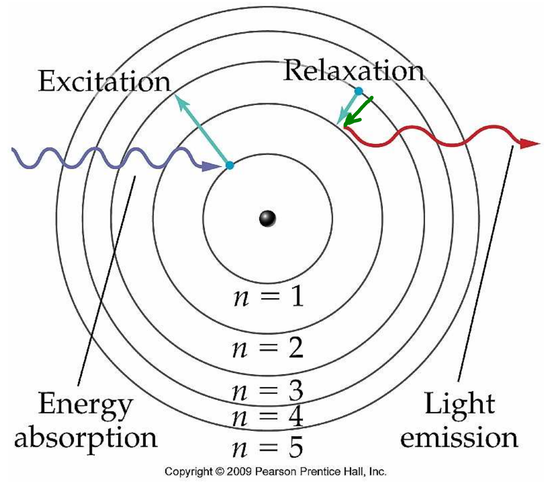


Bohr model

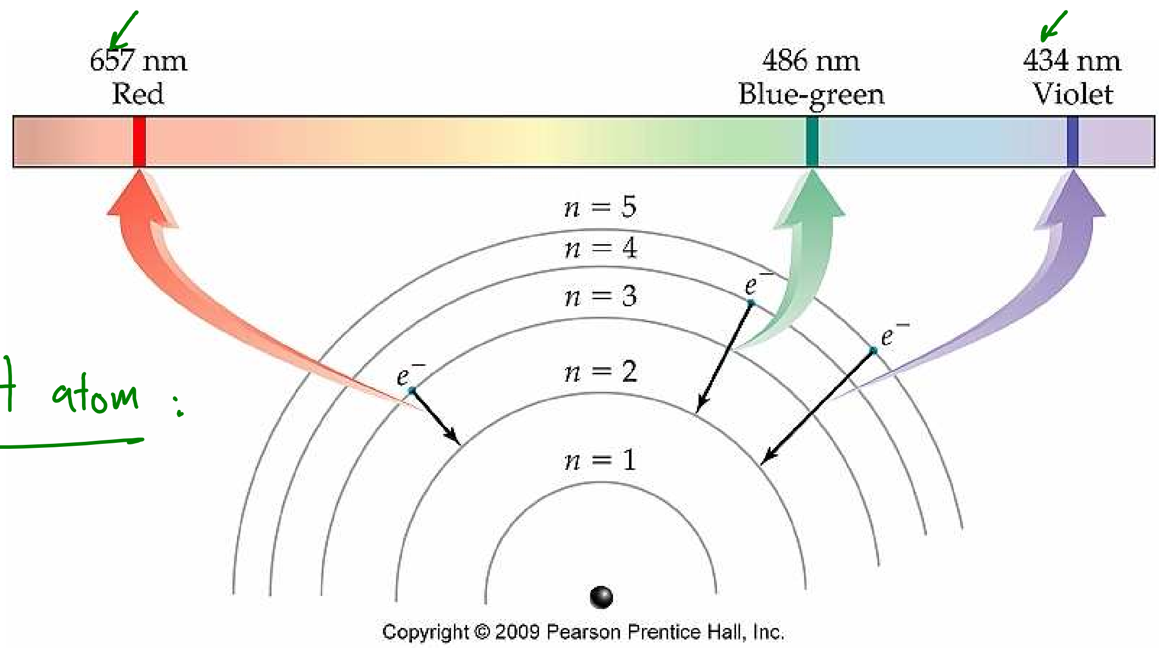
Why are only **certain** colors of light given off by a pure gas sample?

The **Bohr model** can help explain why:

- Electrons orbit in specific fixed distances from nucleus, called **shells**
- Electrons **jump** to higher, more distant orbits when they **absorb** energy (excitation)
- They **drop** down to lower orbits when they **give off** energy, usually as light (relaxation)



H atom:



Quantum-mechanical model

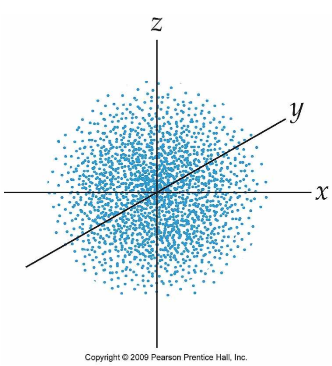
Shortcomings of the Bohr model:

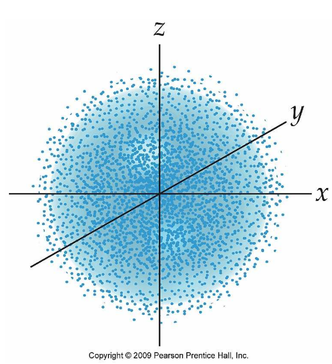
- Can predict the energies of electrons in a hydrogen atom, but not for any other element
- Assumes electrons travel in single circular paths, not likely
- Does not explain periodic table behavior

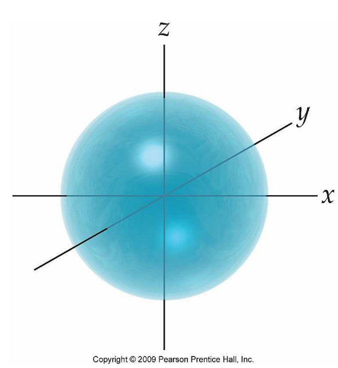
Quantum mechanical model:

- Assumes electrons can act like particles **or** waves (supported by experimental evidence)
- Exact position or path of a single electron are impossible to predict
- But, you can predict the probability of finding an electron within a certain space:

Orbital: 3-dimensional shape that defines the **probability** of finding an electron







The quantum mechanical model has **shells** like the Bohr model

- *n* = 1, 2, 3, 4, … (principal quantum number)
- As *n* increases, energy of the electron increases, and **average** distance from the nucleus increases.

But shells alone cannot explain electron behavior. Each new row on the periodic table is a new shell, and the major sections (main group, transition, etc) each have their own **subshell**.

Each shell has *n* subshells:

Shell	# subshells	Subshell letters
n = 1	1	1s
n = 2	2	2s, 2p
n = 3	3	3s, 3p, 3d
n = 4	4	4s, 4p, 4d, 4f

Electron configurations

Period	H							He
1	($1e^-$)							($2e^-$)
Period	Li	Be	B	C	N	O	F	Ne
2	($3e^-$)	($4e^-$)	($5e^-$)	($6e^-$)	($7e^-$)	($8e^-$)	($9e^-$)	($10e^-$)

If the elements in period 1 have their electrons in the 1s subshell,
the s subshell can hold a maximum of _2_ electrons.

Electron configuration: subshell$^{\# e-}$

H: $1s^1$ **He**: $1s^2$

Actually, **every s subshell** can hold a max of _2_ electrons (including 2s, 3s, 4s, 5s, etc)

In period 2, we fill the 2nd shell (2s and 2p subshells)

Li: $1s^2 2s^1$ **Be**: $1s^2 2s^2$

When we cross to a new section on the periodic table, a new subshell is being filled. B-Ne fill into the _2p_ subshell

B: $1s^2 2s^2 2p^1$ **C**: **N**:

O: $1s^2 2s^2 2p^4$ **F**: **Ne**: $1s^2 2s^2 2p^6$

Electron configurations and the rest of the periodic table

Available subshells to fill:

1s
2s 2p
3s 3p 3d ← 1st available d subshell
4s 4p 4d 4f ← 1st available f
5s 5p 5d 5f
6s 6p 6d
7s 7p

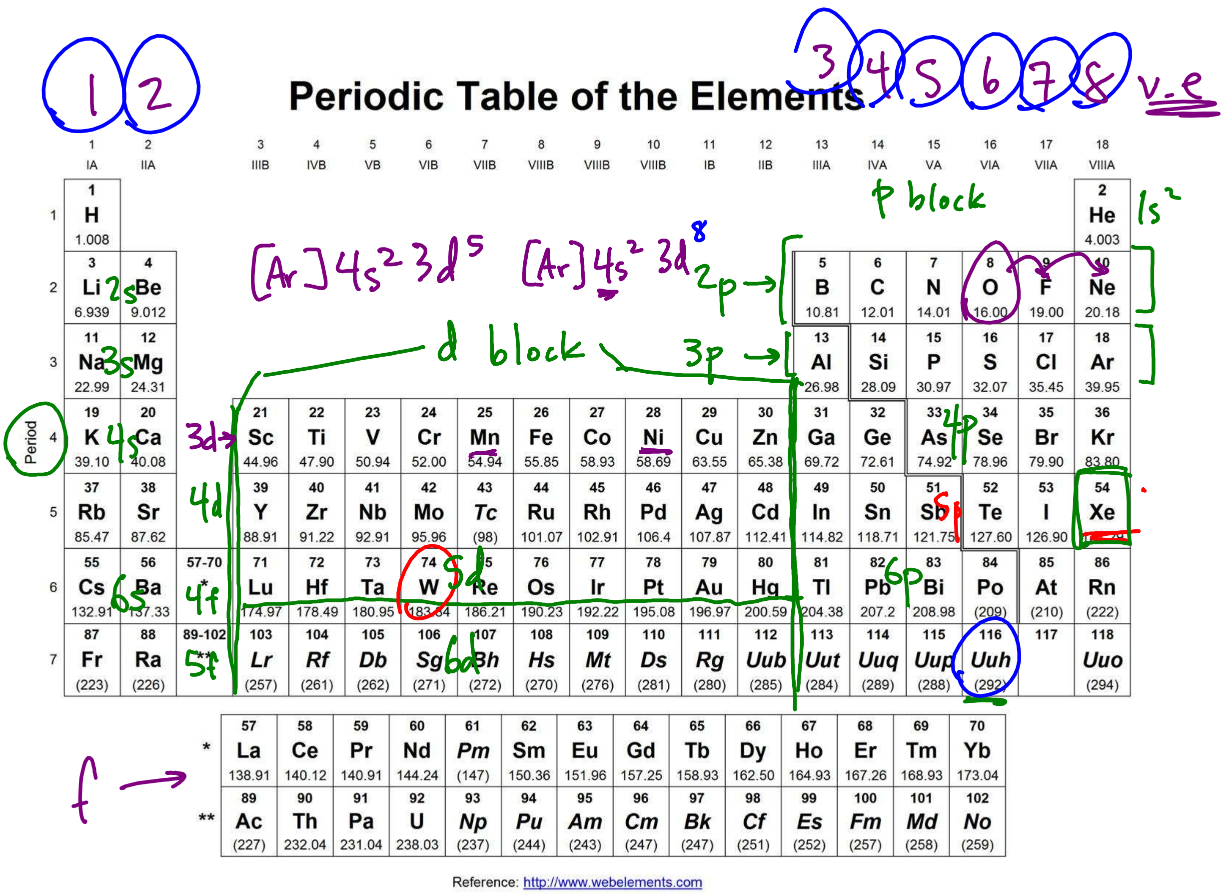
Subshell	Max # e^-
s	2
p	6
d	10
f	14

Na: Ar:

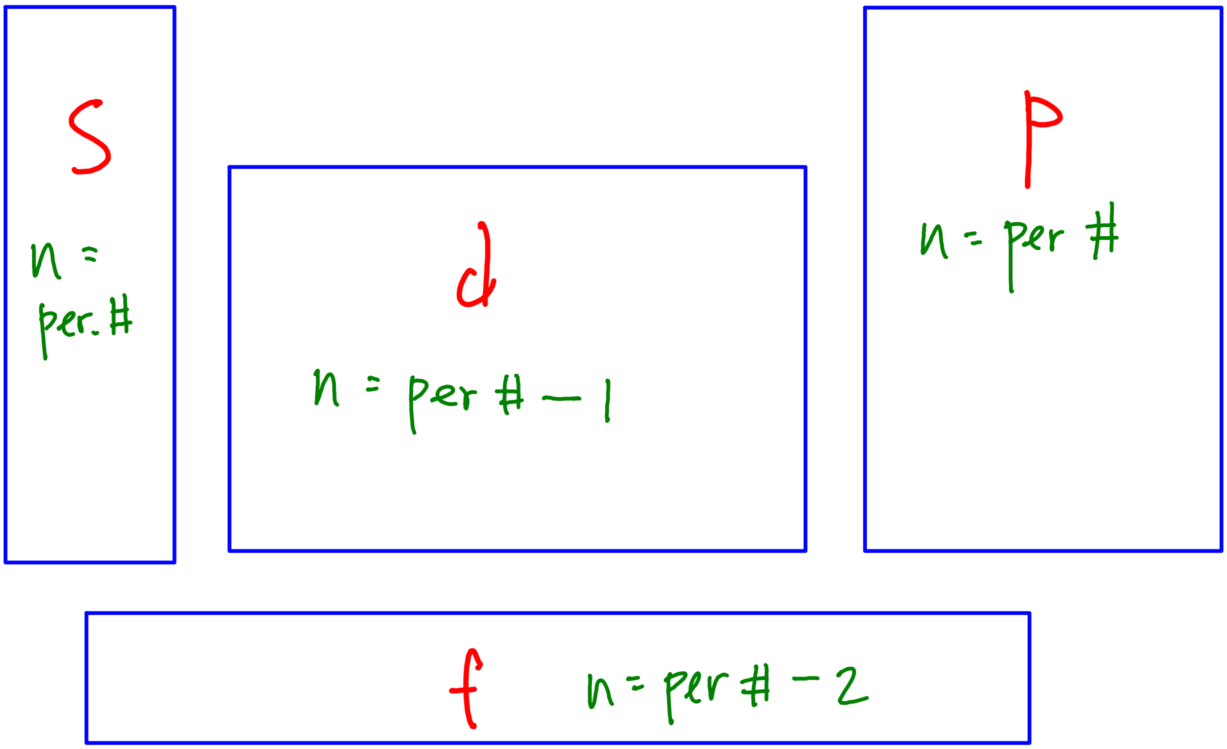
Ca: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ Sc: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

n

Ba:



Sections of the periodic table



Filling order (to check work only!)

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

W: .... $6s^2 4f^{14} 5d^4$

Abbreviated electron configurations, valence electrons

Noble gases all have **full subshells**

Abbreviated electron configuration starts with the nearest smaller noble gas in brackets, then continues

2 valence electrons

W: [Xe] $6s^2 4f^{14} 5d^4$ n = 6 : valence shell

Uuh: [Rn] $7s^2 5f^{14} 6d^{10} 7p^4$ n = 7 : valence shell

6 valence e⁻

Valence electrons: electrons in the outermost **shell** (not subshell)

4s subshell is in the *n* = 4 shell
5p subshell is in the *n* = 5 shell

The largest *n* number in an electron configuration is the **valence shell**.

Bi:

Br:

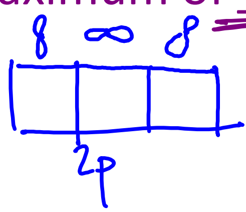
Orbital diagrams

Subshell	Max # e^-	# Orbitals
s	2	1
p	6	3
d	10	5
f	14	7

Recall, an orbital is a ... volume inside of which an e^- is likely to be found

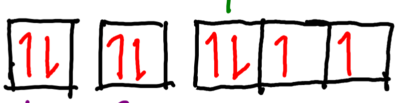
If an s subshell contains a single orbital, how many orbitals are in a p subshell?

Every orbital holds a maximum of 2 electrons.



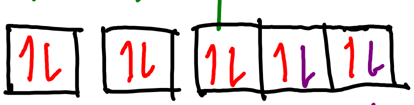
Orbital diagrams:

O: $1s^2 2s^2 2p^4$



fill 1e^- per orbital first before pairing

O^{2-}: $1s^2 2s^2 2p^6$ — 2 added electrons



stable ion (same e^- config as Ne)

Na: $1s^2 2s^2 2p^6 3s^1$

Na^+: loses 1 extra e^- — Ne e^- config