Physics 100 - Fall 2007 - Recitation 5

(1)

In the Bohr model of the atom, what happens to the electron when the atom absorbs a photon? What happens to the electron when the atom emits a photon?

Below is a schematic diagram of an atom with four different states (or orbits) in which the electron could exist. Next to it is a graphical representation of the electron energy in each possible STATE ... $E_1 < E_2 < E_3 < E_4$.

In terms of E_1, E_2, E_3, E_4, what is the energy of the most energetic photon emitted by this atom?

In terms of E_1, E_2, E_3, E_4, what is the energy of the least energetic photon?

Suppose for a moment that $h = 6.6 \times 10^{-34}$ J-s

or

4.1×10^{-21} MeV-s

$E_1 = -13.6\ eV$

$E_2 = -3.4\ eV$

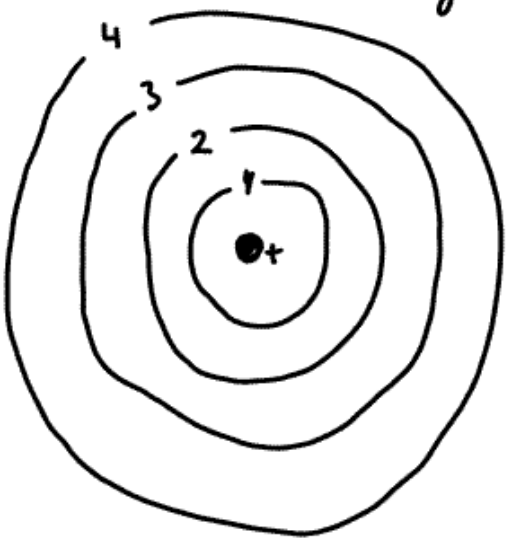
$E_3 = -1.5\ eV$

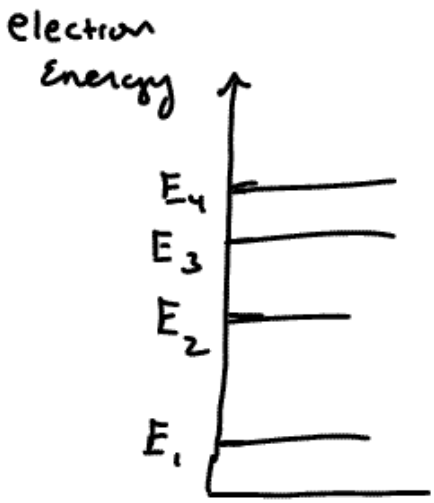
$E_4 = -0.85\ eV$

I know the "−" sign seems strange ... it means the electron is bound in the atom. Just think of scale as offset from zero.

What is the highest frequency light emitted by this atom?

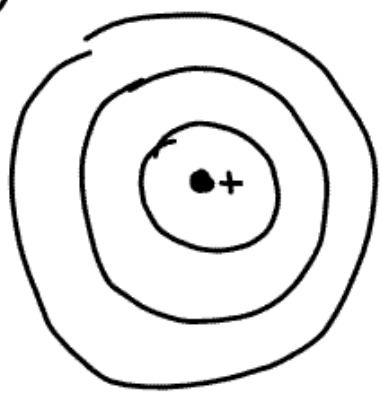
What is the lowest frequency light emitted by this atom?





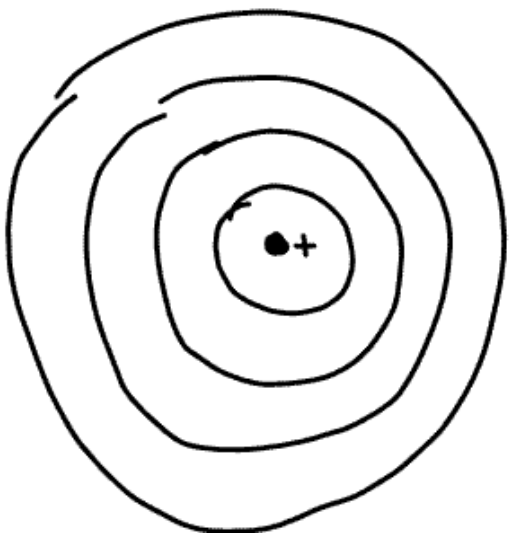
Look on p 196 of Hobson to determine the region of the electromagnetic spectrum where light of this frequency would be found.

(2)



An atom has 3 possible energy states in which the electron could exist. How many spectral lines could be emitted by this atom?

(3)



An atom has 4 possible energy states in which the electron could exist. How many spectral lines could be emitted by this atom?

(4) IT happens that when you calculate the energy of a multi-electron atom using a full-blown quantum mechanical treatment, the atom is MOST stable if it has all the possible quantum STATES in its outermost energy level filled.

(a) What do I mean by the words "MOST STABLE"?

According to quantum mechanics:

Energy level	Number of electrons Allowed
1S	2
2S	2
2P	6
3S	2
3P	6

Increasing energy

names of available quantum STATES (Distribute these in lecture)

Look on the periodic chart.

(b) How can you tell the number of protons in each of the listed element?

(c) Elements are defined primarily by their chemical characteristics.

What do I mean by this?

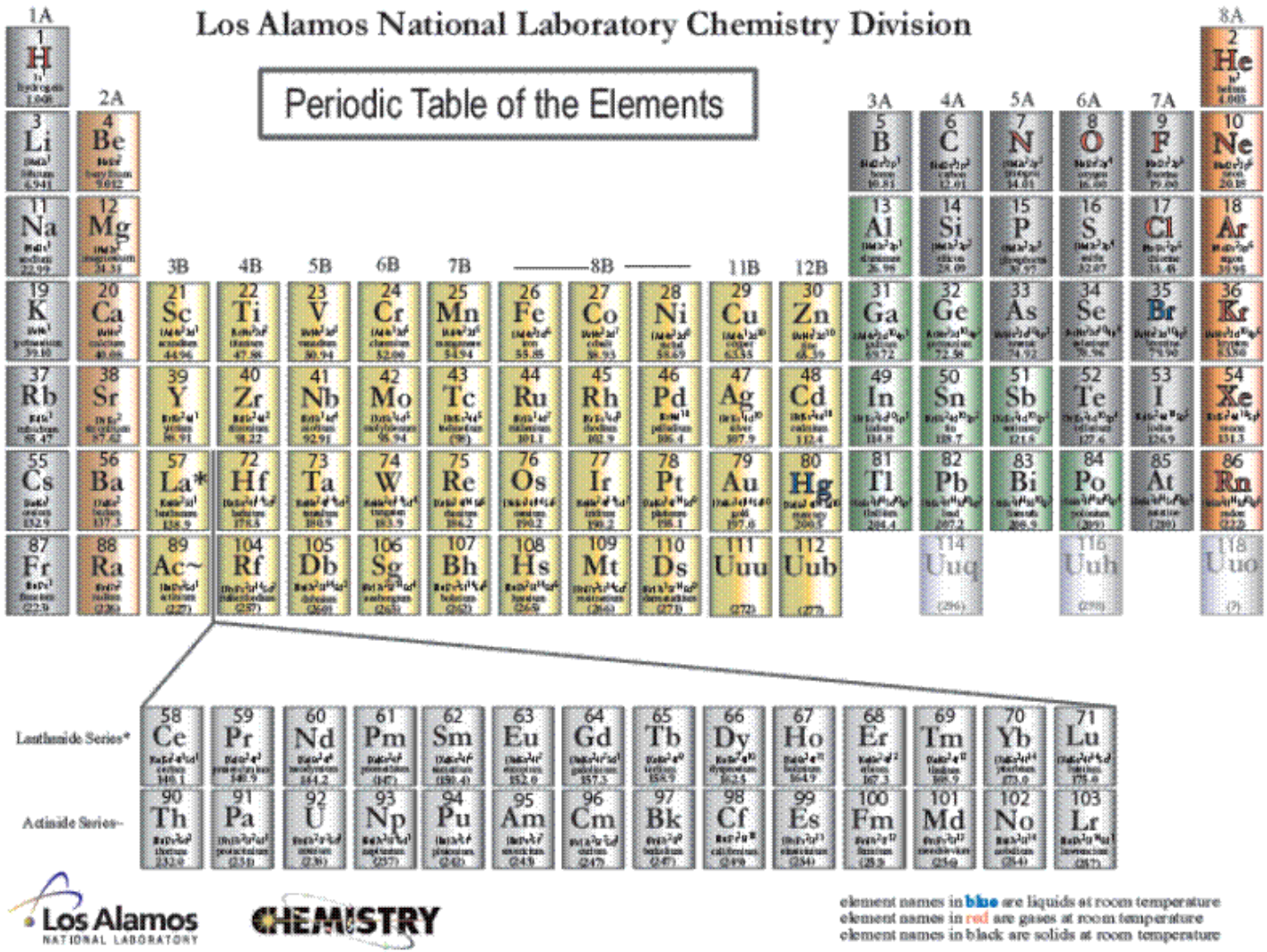
(d) Considering atoms with $Z=1$ (hydrogen) through $Z=18$ (Argon $\equiv$ Ar), which elements would you expect to be most stable (least chemically reactive)?

(e) Can you determine the number of neutrons for each element listed in the Periodic chart?

(f) Do you think the number of neutrons in an atom's nucleus has an affect on it's chemical characteristics?

(g) Which atom would you expect to be larger ... Ne $\equiv$ Neon or Ar $\equiv$ Argon ?

$Z = 10$ $Z = 18$


Los Alamos National Laboratory Chemistry Division
Periodic Table of the Elements
1A
2A
3B
4B
5B
6B
7B
8B
11B
12B
3A
4A
5A
6A
7A
8A
Lanthanide Series*
Actinide Series~
Los Alamos
NATIONAL LABORATORY
CHEMISTRY
element names in blue are liquids at room temperature
element names in red are gases at room temperature
element names in black are solids at room temperature

(5)

hydrogen ($Z=1$, H) reacts with chlorine ($Z=17$, Cl) to form hydrogen chloride molecules which consist of 1 H and 1 Cl atom, written as HCl

From what you know about quantum stability and its dependence on the electron configuration (how the electrons fill the available orbitals),

can you motivate why H and Cl join in a 1-to-1 ratio?

What other atoms would you expect to join with chlorine in a 1-to-1 ratio in a chemical reaction?

What do you suppose might be the ratio of magnesium (Mg) to chlorine (Cl) after a chemical reaction?