WKS 6-2 - Honors
Emission Spectra and The Bohr Atom

Name ______________________________
Period _____ **Date** ____________

The Bohr Atom: Analysis of emission spectra

Read pp. 94 – 97 in the textbook.

1) Electrons are attracted to the nucleus. Why? Discuss ALL particles.
They are negatively charged and attracted to the positive nucleus by coulombic attraction.

2) Since electrons are attracted to the nucleus, it is relatively difficult to move an electron further away from the nucleus. Thus, when an electron does move further away from a nucleus, energy must be:

a) absorbed by the electron
b) released by the electron

3) Thus, when an electron moves further away from the nucleus, the electron must:

a) gain potential energy
b) lose potential energy

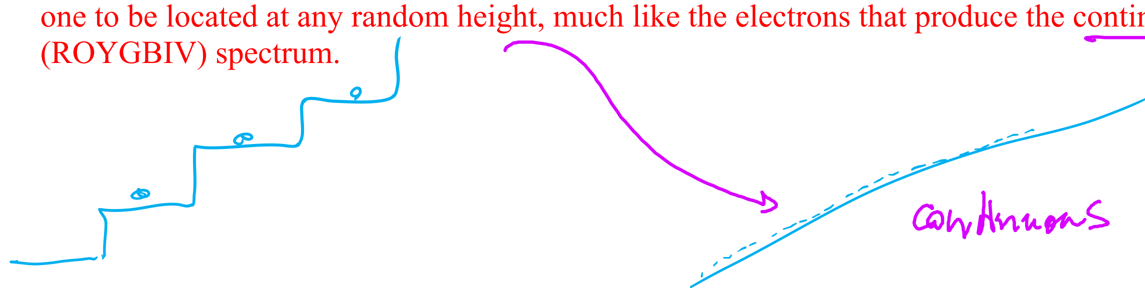
4) Earlier, you looked at the emission spectra produced when electricity was passed through tubes filled with various gases. Answer the following questions about how electrons are involved with producing the light.

a) When electricity is passed through a gas, some electrons in the atoms of gas absorb the energy. What must happen to the energy of the electrons when they **absorb** this energy?
The electrons' energy must *increase*. The electrons get *excited*.

b) Describe what naturally happens to the electrons next. Explain why light is emitted.
The electrons are attracted back towards the nucleus and *relax* to a lower energy level. As they lose energy, this energy is emitted in the form of one photon of light.

5) Describe Bohr's model of the atom. Where are the electrons located?
In Bohr's planetary model of the atom, electrons circle the nucleus in well-defined, concentric *orbits*, with increasing potential energy as they get farther from the nucleus. Electrons can exist only on these orbits, and are not allowed to exist at energies between the orbits.

6) In Bohr's model of the atom, electrons are *quantized*. This means that electrons can only occupy certain energy levels. In contrast, electrons in the sun or in white light sources have *continuous* energy levels available. How is this similar to walking up stairs versus walking up a ramp?
Walking up stairs, one can only be located at discrete heights, like electrons in an atom. A ramp allows one to be located at any random height, much like the electrons that produce the continuous white-light (ROYGBIV) spectrum.

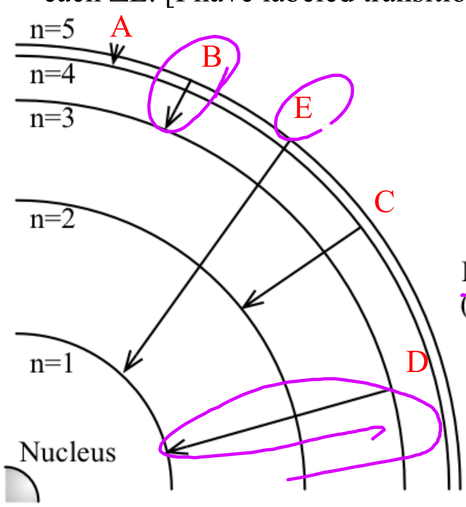


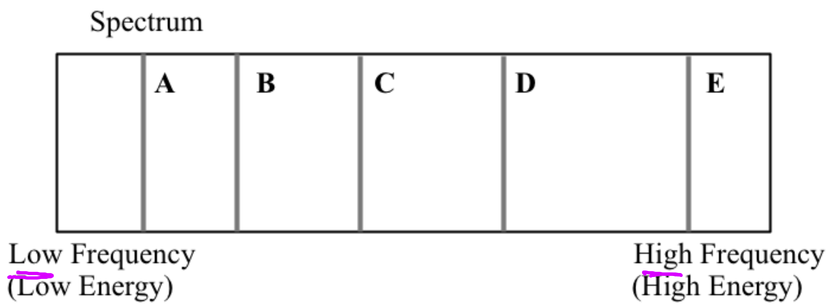
7) How do the emission spectra of gases support Bohr's model of the atom? *(Hint: are all possible light energies observed?)* How is a continuous spectrum, such as a rainbow, observed from the sun or other white light source, different from these line spectra?

Since only certain energy *differences* are observed, then only certain energy values are allowed. In a continuous spectrum of white light, the energy levels are so close together that essentially every energy is observed.

8) Below is a hypothetical atom with five indicated transitions and its emission spectrum.

a) Using what you know about the relationship between the ΔE and the frequency of light, label the energy diagram with the correct lines from the spectrum and indicate which energy levels comprise each ΔE. [I have labeled transition A to get you started.]



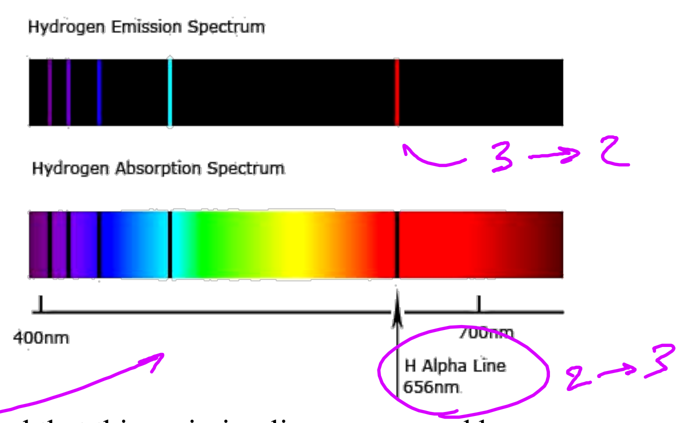


ΔE_A = $E_5 - E_4$	ΔE_C = $E_4 - E_2$	ΔE_E = $E_5 - E_1$
ΔE_B = $E_5 - E_3$	ΔE_D = $E_3 - E_1$	

b) Bohr was able to determine the energy levels (not just the differences) by noticing that many of the energies (frequencies) added to give another energy. Which two energies in this spectrum add up to a one of the other energies?

$\Delta E_E = \Delta E_B + \Delta E_D$ ($\Delta E_{5\text{-}1} = \Delta E_{5\text{-}3} + \Delta E_{3\text{-}1}$)

9) At right is the familiar H emission spectrum and below is its absorption spectrum. This is created by passing white light through a heated sample of hydrogen gas and then through a prism.



a) The black gaps in the absorption spectrum indicate where light has been removed. If emission spectra are created by electrons emitting light, what must be the cause for this missing (absorbed) light?

Instead of emitting light by relaxing, electrons in an absorption spectrum absorb the light and become excited.

b) The red 656 nm line is labeled in both spectra. You found that this emission line was caused by an electron relaxing from n=3 to n=2. What transition is occurring in the absorption spectrum? Why must the wavelengths be the same?

Since the electron is being excited, it must be going from n=2 to n=3. The wavelengths are the same because the energy difference between n=2 and n=3 is the same, regardless of whether the electron is being excited (moving up) or is relaxing (moving down).