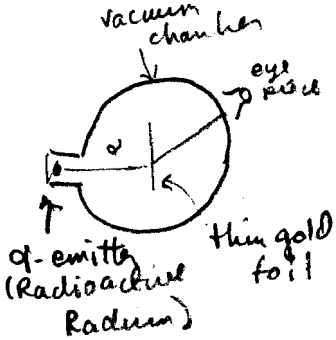
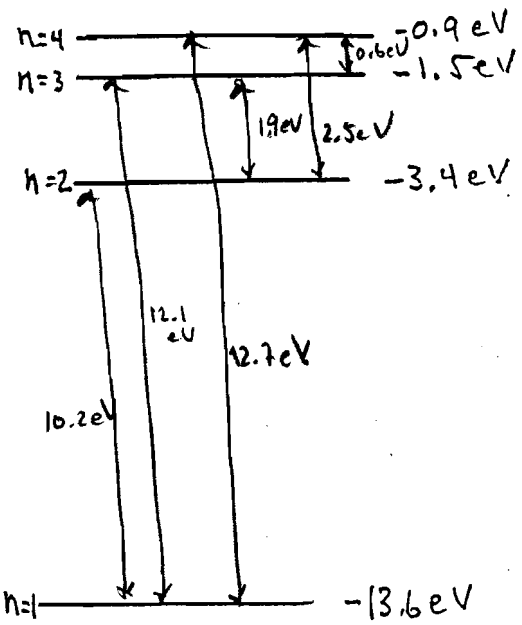
Physics 100 HW 13 Due April 25, 2007 Name S. Olsen

1. With the help of a sketch, briefly describe Rutherford's α-particle scattering experiment. What results led him to propose a planetary model for the atom rather than a "plum pudding"-type model?



Rutherford scattered α-particles from a thin gold foil. The occasional scatter of an α-particle by a very large angle was evidence in favor of the planetary model & against the "plum-pudding" model

2. What are the possible photon energies absorbed during transitions between the first four energy levels of hydrogen? (Indicate the transition corresponding to each energy on the diagram at the right.)



$n=2 \leftrightarrow n=1$ 10.2eV
$n=3 \leftrightarrow n=1$ 12.1eV
$n=4 \leftrightarrow n=1$ 12.7eV

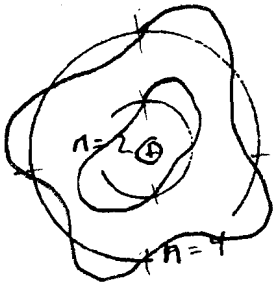
$n=3 \leftrightarrow n=2$ 1.9eV
$n=4 \leftrightarrow n=2$ 2.5eV
$n=4 \leftrightarrow n=3$ 0.6eV

3. An electron in the hydrogen atom jumps from the $n = 3$ energy level ($E_3 = -1.5eV$) to the $n = 2$ energy level ($E_2 = -3.4eV$). What frequency light is emitted? (Here you will have to remember that $1\ eV = 1.6 \times 10^{-19}\ J$.)

$E = (3.4 - 1.5)\,eV = 1.9eV = 1.9\,eV \times 1.6\times10^{-19}\ J/eV = 3.0\times10^{-19}\ J$

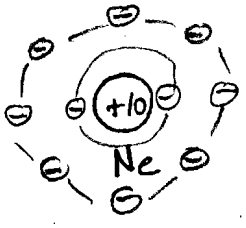
$E = hf \Rightarrow f = \frac{E}{h} = \frac{3.0\times10^{-19}\ J}{6.6\times10^{-34}\ Js} = 0.46\times10^{+15}\ Hz = 4.6\times10^{14}\ Hz$

4. deBroglie said that electrons travel through space like waves. Sketch what the electron waves in the n=2 and n=4 Bohr orbits in hydrogen might look like.



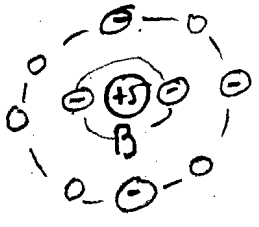
5. i) Sketch the arrangement of the orbital electrons for helium ($Z = 2$) and neon ($Z = 10$). Why don't these atoms form compounds with other atoms?

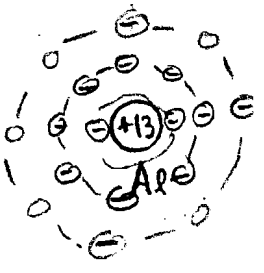
They both have filled outermost electron shells



ii) Sketch the arrangement of the orbital electrons for boron ($Z = 5$) and aluminium ($Z = 13$). Why do they have similar chemical properties?

They both have 3 electrons in their outermost electron shell





6. Oxygen ($Z = 8$) can combine with two hydrogen atoms to make a molecule of water (H_2O). Make a sketch showing how the oxygen and hydrogen electrons are shared in the water molecule.