Problem Set 10: Bohr Model: Predicting Discrete Energy Levels

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday November 10$^{\text{th}}$, 2017

Problem 1

How much energy must a hydrogen atom absorb to raise its electron from the energy level $n = 1$ to the following energy levels:

a) $n = 2$

b) $n = 7$

Problem 2

An electron in a hydrogen atom drops from the energy level $n = 3$ to $n = 2$, followed by a drop from $n = 2$ to $n = 1$. Show that the total energy emitted during this process is the same as if the electron had fallen directly from the energy level $n = 3$ to $n = 1$.

Problem 3

The Bohr theory can be extended to non-hydrogen one electron ions such as He^{+} and Li^{2+}, in which case the energy depends on the different atomic numbers Z for the respective atom. How much energy in Joules is required to excite the electron in Li^{2+} from $n = 1$ to $n = 2$?

Problem 4

Consider the electronic structure of an atom:

a) What are the n, l, and m_l quantume numbers cooresponding to the $4p$ orbital?

b) List all the possible quantum number values for an orbital in the $4f$ subshell.

c) In what specific subshell will an electron having the quantum numbers $n = 3$, $l = 2$, and $m_l = -1$ be found?

Problem 5

A certain atomic orbital contains an electron with quantum numbers $n = 3$, $l = 2$, $m_l = 0$, $m_s = +\frac{1}{2}$.

a) If a second electron were found in the same orbital, what would be its quantum numbers?

b) If a second electron were found in the same subshell, what would be an acceptable set of quantum numbers for that electron?

Problem 6

a) What is the energy of the photon emitted when the electron in a hydrogen atom drops from the energy level $n = 6$ to the energy level $n = 1$?

b) An electron in the hydrogen atom relaxes from a high energy excited state to the $n = 3$ level. Upon relaxation, a photon of 956 nm is emitted, determine the initial state that the electron must have started from.