UNIVERSITÄT LEIPZIG

Experimental Physics IV IPSP

Problem Set 2

Deadline: Thursday, 21.04.2011, before the lecture

Problem 4:   2+2+3+2 points

The postulates in Niels Bohr's publication "*On the Constitution of Atoms and Molecules" (1913)* are:

1. An electron moves in a circular orbit around the nucleus under the influence of the Coulomb attraction between the electron and the nucleus.
2. An moving electron does not radiate electromagnetic energy according to Planck's law. Therefore, the total energy of an electron remains constant.
3. It is only possible for an electron to move in an orbit for which its orbital angular momentum L is an integral multiple of $\hbar$.
4. An electron can only gain or lose energy by jumping from one allowed orbit to another. The energy of the absorbed or emitted photon obeys $\Delta E(n, m) = E_n - E_m = hf$.

Calculate the energy $\Delta E(n, m)$ according to Bohr's model of atoms!

a) Use the 1. Postulate (classical movement) to obtain the velocity of an electron around the nuclei!
b) Use the 3. Postulate (quantization of angular momentum) to calculate the radii of the orbitals!
c) Use your results of a) and b) to determine the total energy E_n of an electron in the orbital n! Finally, calculate $\Delta E(n, m)$!
d) Name at least two issues of the Bohr model!

Problem 5:   5 points

How many absorption lines of atomic hydrogen can be observed with a wavelength between $94.5 \text{ nm} \leq \lambda \leq 110 \text{ nm}$?

Problem 6:   5 points

In Millikan's oil drop experiment an oil droplet (diameter $d = 1\mu m$, density $\rho \approx 0.92 \frac{\text{g}}{\text{cm}^3}$ is falling between two condensator plates (electric field is turned off, distance of plates: $a = 3mm$) with a constant velocity downwards. Now, the electric field is switched on ($E = 59V$) and the droplet is moving upwards with the same velocity.

How many elementary charges does the droplet have?