Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 2 – IPSP

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Exercise Sheet 9 (SoSe 2012)

Date of Issue: June 8^{th} 2012

Date of Submission: June 15^{th} 2012

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. Calculate the electric field a distance z from a uniformly charged infinite flat non-conducting sheet by modeling the sheet as a continuum of infinite straight lines of charge. (6 Points)

2. A non-conducting spherical shell of inner radius R_1 and outer radius R_2 has a uniform volume charge density ρ. (a) Find the total charge on the shell. (b) Find expressions for the electric field everywhere. (8 Points)

3. A uniform electric field has a magnitude 2.00 kV/m points in the $+x$ direction. (a) What is the electric potential difference between the $x = 0.00$ m plane and the $x = 4.00$ m plane? A point particle that has a charge of $+3.00\,\mu C$ is released from rest at the origin. (b) What is the change in the electric potential energy of the particle as it travels from the $x = 0.00$ m plane to the $x = 4.00$ m plane? (c) What is the kinetic energy of the particle when it arrives at the $x = 4.00$ m plane? (d) Find the expression for the electric potential $V(x)$ if its value is chosen to be zero at $x = 0$. (6 Points)

4. (a) A positively charged particle is on a trajectory to collide head-on with a massive positively charged nucleus that is initially at rest. The particle initially has kinetic energy K_i. In addition, the particle is initially far from the nucleus. Derive an expression for the distance of closest approach. Your expression should be in terms of the initial kinetic energy K_i of the particle, the charge ze on the particle, and the charge Ze on the nucleus, where both z and Z are integers. (e : charge of an electron) (b) Find the numerical value for the distance of closest approach between a 5.00-MeV α particle and a stationary gold nucleus and between a 9.00-MeV α particle and a stationary gold nucleus. (The values 5.00 MeV and 9.00 MeV are the initial kinetic energies of the alpha particles. Neglect the motion of the gold nucleus following the collisions.) (c) The radius of the gold nucleus is about $7 \cdot 10^{-15}$ m. If α particles approach the nucleus closer than $7 \cdot 10^{-15}$ m, they experience the strong nuclear force in addition to the electric force of repulsion. In the early twentieth century, before the strong nuclear force was known, Ernest Rutherford bombarded gold nuclei with α particles that had kinetic energies of about 5 MeV. Would you expect this experiment to reveal the existence of this strong nuclear force? Explain your answer.